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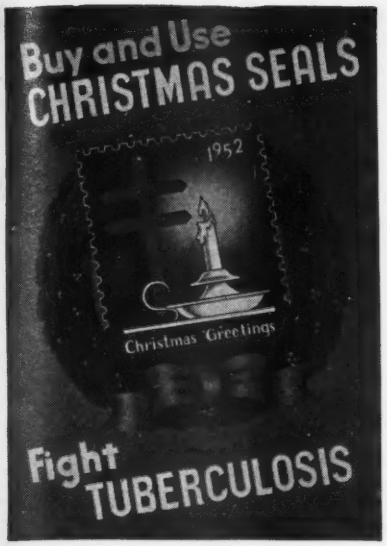

ON THE COVER

AT CHRISTMASTIME young folks dream of gleaming sleds and unlimited expanses of snow. Artists, too, dote on the white stuff, and it makes a favorite subject for calendar illustrations. Although construction men are both visionary and aesthetic, they are also realistic. A snowbank is an obstacle when anything is to be built aboveground, and snow can cease to be beautiful to the fellow who has to push it aside when storm piles upon storm. Fortunately, equipment builders have come along with bulldozers and the like, and getting down to *terra firma* isn't the job it used to be. Our cover picture shows the advance guard for a crew that is stringing a transmission line across Kildala Pass in British Columbia.

IN THIS ISSUE

OF FIVE thousand former wagon and carriage builders, Studebaker Corporation is the only one that now makes automobiles, although one other firm, Fisher Brothers, does manufacture bodies for General Motors cars. Our leading article tells the story of Studebaker, which observed its hundredth anniversary earlier in the year.

●

ENGINEERS sometimes almost need a shoehorn to fit more structures into the already crowded zone just below the surface of Manhattan Island. Much finesse is required to dodge the existing foundations, passageways and the ganglia of pipes and conduits. Such a job is now underway at the busy Grand Central subway station. Page 335.

●

AFTER having been under construction for more than thirteen years, the multiple-feature Colorado-Big Thompson Project of the Bureau of Reclamation is nearing completion. A review of its purposes and a description of current work starts on page 339.

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EDITORIAL CONTENTS

Studebaker's First Hundred Years—*C.H.Vivian* 328
Rock Surgery Under Busy Manhattan—*J.C. Pierce* 335
"Big Tom" Project Nearing Completion—*L.A. Luther* 339
An American Engineer Abroad 344
Alcan Tunnelers Set New Record 346
Air Feed Boosts Screw-machine Production 347
Editorials—Gold, Enigma Metal—Desert Detonations 348
This and That 349
Moles Awards to Kiewit and Palmer 350
Air Mules 351
Peat as a Roadbuilding Material 351
Industrial Notes 352
Books and Industrial Literature 359

ADVERTISING CONTENTS

American Air Filter Co., Inc. 31
Anaconda Copper Mining Co. 26
Armstrong Machine Works 34
Bethlehem Steel Company 17
Bucyrus-Erie Company 12, 13
Compressed Air Magazine Co. 38
Cook Mfg. Co., Inc., C. Lee 30
Crucible Steel Co. of America 32
DeZurik Shower Co. 35
Dollinger Corporation 3
Donaldson Co., Inc. 25
du Pont de Nemours & Co., E. I. 37
Eimco Corporation, The 7, 27
Elliott Company 18
Fluor Corporation, Ltd., The 15
General Electric Company 10, 11
Hunt & Son, Inc., C. B. 14
Industrial Clutch Corporation 40
Ingersoll-Rand Company ..... 9, 28, 29, 3rd Cover
Madison-Kipp Corporation 33
Maxim Silencer Co., The 23
National Forge & Ordnance Co. 34, 35
Naylor Pipe Company 24
New Jersey Meter Company 38
Norton Company 4
Nugent & Co., Inc., Wm. W. 22
Powell Company, The Wm. 16
Roebling's Sons Company, J. A. 6
Sarco Company, Inc. 34
Sauerman Bros., Inc. 19
Shell Oil Company 39
SKF Industries, Inc. 8
Texas Co., The ..... 2nd Cover
Timken Roller Bearing Co., The ..... Back Cover
Victaulic Co. of America 21
Vogt Machine Co., Henry 36
Walworth Company 5
Waukesha Motor Company 20
Wood's Sons Co., T. B. 35

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Studebaker's First Hundred Years

Nation's Fourth-largest Automobile Firm Grew from Brother-owned Wagon Shop

C. H. Vivian

STUDEBAKER BROTHERS

A portrait made in 1877. From the left: Clem, president; Peter, treasurer; Henry, cofounder in 1852, retired in 1858; Jacob, secretary; and John, vice-president. Two of Henry's sons, both more than 70 years old, retired from life-long Studebaker service last July.

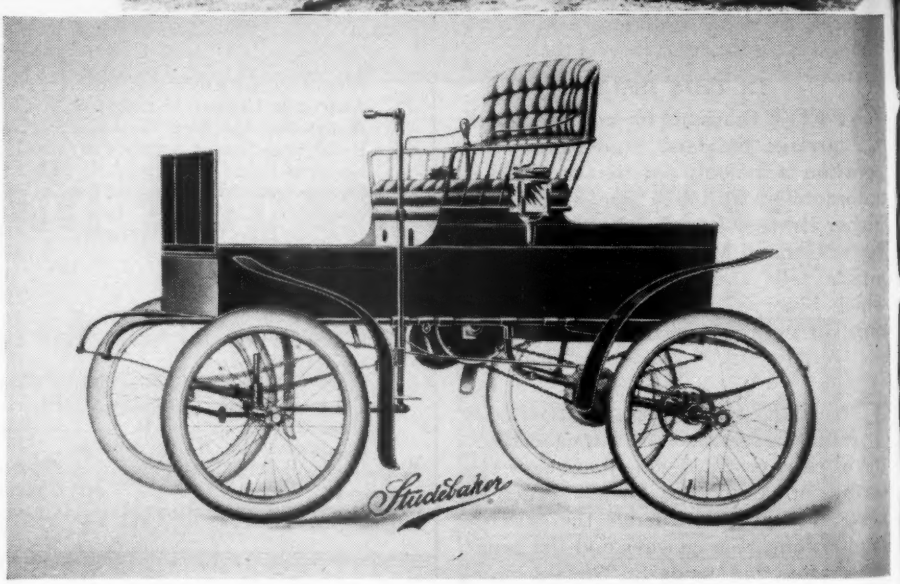
TYPICAL FARM WAGON

Before highways were hard surfaced, Studebaker boasted that ruts made by its vehicles were to be found the world over. Farm wagons like the one shown were the leading seller, but the line included buggies, spring wagons, panel wagons, horse-drawn sprinklers and street sweepers. The sale of horse-drawn vehicles was discontinued in 1920.

THIS is the centennial year for the Studebaker Corporation of South Bend, Ind., the only automobile manufacturer that was building vehicles prior to the appearance of the "horseless carriage." During the first half of its first century in business Studebaker made wagons, carriages and even harness. It turned out its first automobile in 1902, and has been building cars ever since. In recent years it has become the fourth-largest auto manufacturer, and it is significant to note that it has produced as many vehicles for civilians in the past five years as it did in the 95 years that went before.

These statements epitomize the aggressiveness of the current Studebaker management. The corporation's three passenger-car models—Champion, Commander and Land Cruiser—account for 4 percent of the nation's automobile output since World War II, whereas the company received only 2 percent of the total business before that time. Although Studebaker is rather small in comparison with the Big Three car makers—General Motors, Chrysler and Ford—only 62 American manufacturing concerns of any kind topped Studebaker's dollar volume of sales in 1951.

The company's postwar robustness came about primarily through a rather daring fling at automobile designing. The public took a fancy to the somewhat revolutionary 1946 model that looked almost the same from either end. Attracted by its smart lines, buyers found that the cars were also sturdy and unusually economical to operate. Since



FIRST AUTOMOBILE

The first Studebaker car was an open electric runabout produced in 1902. Powered by a 24-cell battery, it had four forward speeds of 3, 5, 9 and 13 miles an hour. It was 73 inches long, 29 inches wide, and weighed 1350 pounds. The first gasoline-driven model appeared in 1904. Electrics were not made after 1912.

MILITARY-TRUCK LINE

Since Studebaker sold 100 wagons to the U.S. Army in 1857 it has built thousands of vehicles for the Government. In times of national emergency it devotes a considerable part of its plant and resources to filling military orders and is currently turning out heavy-duty trucks for both the Army and the Navy.

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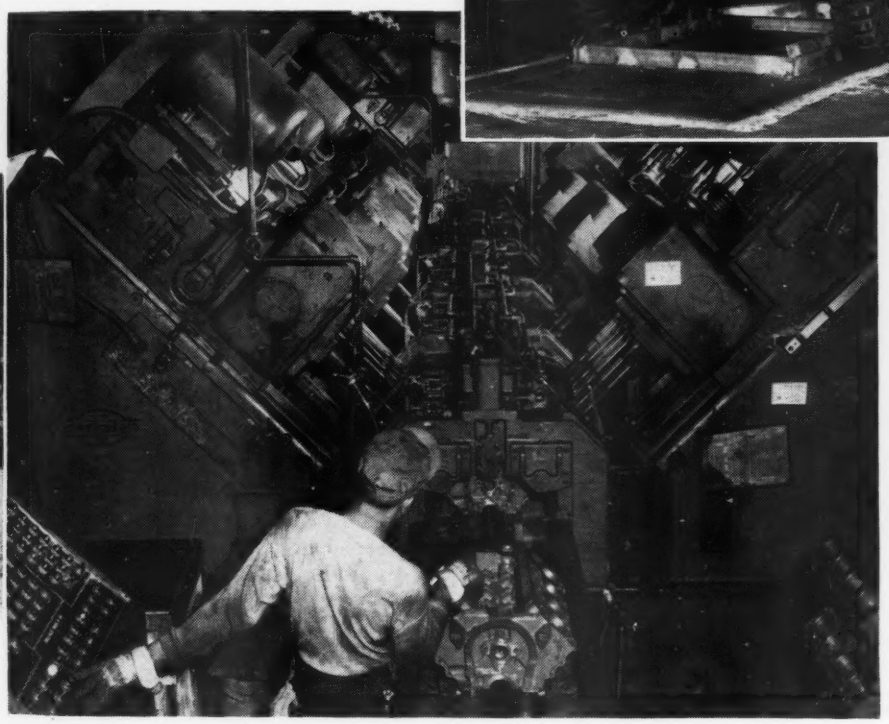
AUTOMATIC MACHINE TOOL

This 14-station Greenlee machine has 189 spindles for drilling, reaming and tapping V-8 engine blocks. From it the blocks pass to another Greenlee unit of ten stations for further processing.



then Studebaker's place in the industry has become well established. Incidentally, for those who wonder why the bullet-nose front end (Studebaker men call it the B-29) was abandoned in 1952, the answer is that sampling of the public taste indicated that the majority of those queried prefer more conventional contours.

As everyone knows, automakers have had their anxious periods during the past ten years, what with war, materials shortages, labor turmoil and other harassments. Long before it was foreseen in World War II that cars for civilians would be curtailed, Studebaker had converted largely to the manufacture of airplane engines. Even earlier, in 1939, it had begun to turn out 2½-ton military trucks and was able to weather the economic storm in good fashion.

When fighting ceased, the company shifted back to its established line without great difficulty. In addition to striking a popular note with its passenger cars, it put out a pick-up truck that likewise became popular quickly. To handle the mounting truck business, the firm bought from the Government the new factory in which it had been building aircraft engines. It is a modern, 1-story structure that contains just short of a million square feet of floor space. Commercial vehicles produced there have constituted one-quarter of the firm's sales volume during the past six years.

At the time the Korean emergency developed, Studebaker was operating its factory and assembly plant at South Bend, as well as assembly plants at Los Angeles, Calif., and Hamilton, Canada; was putting up a factory at New Brunswick, N.J., and contemplating the construction of another one at Dallas, Tex. When efforts to stop hostilities failed, the company again turned rather heavily to defense production. Consequently, military trucks are once more rolling off the assembly line in the South Bend plant. In another section of the same expansive building, at New Brunswick, and in a government-owned structure in Chicago, tooling for the manufacture of jet engines has been completed and the first units were delivered to the Air Force last September. Defense business now makes up nearly half of Studebaker sales, and the proportion will be still larger in a few months.

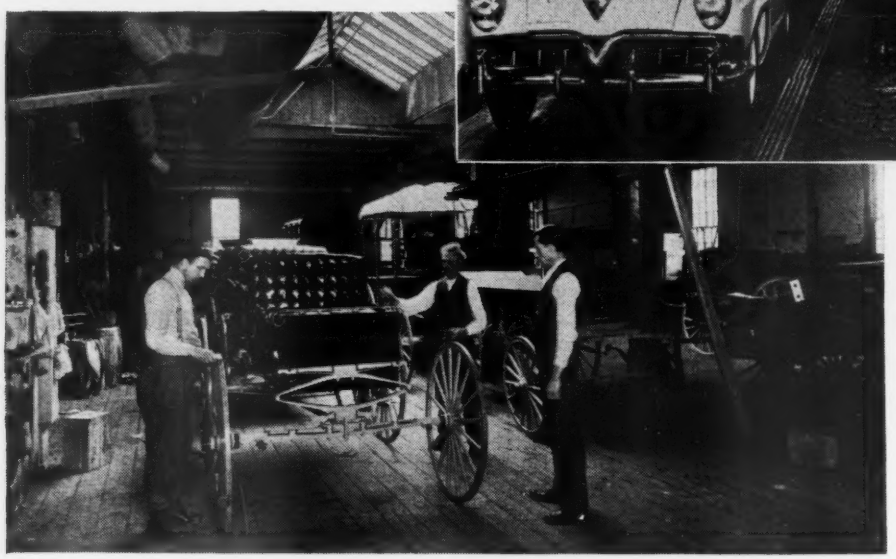
Thus does Studebaker exhibit facility in changing its product to keep in step with shifting economic conditions resulting from lack of international amity. In the first nine months of 1952 it turned out 163,763 passenger cars and trucks. This represented a drop of 63,195 from the like period in 1951 and was caused mainly by the steel strike. However, the total revenue of $385 million was virtually the same as in the corresponding 1951 interval.

The Studebaker story had its real beginning in 1835 when John Studebaker, a Gettysburg, Pa., blacksmith, built a covered wagon in which to move his family and belongings to Ashland, Ohio. The vehicle was of the sturdy Conestoga type that had its origin only a short distance from Gettysburg. In 1851, the same wagon carried the family to South Bend, Ind. By that time there were five Studebaker boys. In the following year, two of the older ones, Henry and Clem, decided to go into business, and on February 16, 1852, established a blacksmith and wagon-building shop under the name of H. & C. Studebaker. It is reasonable to assume that the family Conestoga wagon served as their inspiration and model. They had $68 in cash, two sets of blacksmith tools and no employees. On the first day they took in 25 cents for putting two shoes on a horse.

The first year's production was three wagons. In return for helping to make them, another brother, John, received one of the vehicles and forthwith pooled it with a California-bound wagon train as payment for his passage across the country. The wagon turned out to be

ASSEMBLY LINES OF TWO ERAS

Assembly lines are not new, but they have changed. Below, inspectors are seen checking a carriage before approving it for sale. Parallel passenger-car lines of today are pictured at the right. They can turn out a machine every 50 seconds.



one of the most important ever to bear the Studebaker name, for had John not gone to California it is doubtful if the business in South Bend would ever have amounted to much. When John reached the gold-mining camp of Placerville, which was then called Hangtown, there was a great shortage of wheelbarrows, and he was persuaded to start building them instead of panning for gold. In five years he saved $8000, and then heeded his brothers' earnest appeals to come home and help them with their infant business.

In South Bend, Henry and Clem were turning out wagons at the slow pace of twelve a year. Hampered by lack of capital, they couldn't start work on a vehicle until they had an order for it. John returned to Indiana in 1858 via the Isthmus of Panama and the Port of New York, from where he rode a train to South Bend. Railroads were new then and John became enthusiastic over the future of transportation. He reasoned that there would be a great interchange of goods and that many wagons would be needed to haul them to and from rail shipping points. Less imbued with this enthusiasm was brother Henry, who wanted to acquire a farm near South Bend and work it. Everybody was satisfied when John bought out Henry's interest and put the remainder of his $8000 nest egg into the business.

With money in the bank, the shop was now able to build wagons without waiting for customers, and it soon had three on hand. By that time a fourth brother, Peter, was a merchant in Goshen, Ind., and he was persuaded to stock the vehicles for sale. He quickly disposed of them and went to South Bend to arrange for more. In 1863 he decided to give up his store and work for Clem and John. Meanwhile, the outbreak of the Civil War had created a demand for wagons, ammunition carts and ambulances, and the Studebakers were getting a good share of the business.

Peter took on the job of selling the shop's products, and his affiliation was confirmed by one of the simplest agreements ever drawn up. The first of its two sentences read: "I, Peter Studebaker, agree to sell all the wagons my brother Clem can make." Underneath this Clem wrote: "I agree to make all he can sell." Both affixed their signatures.

At the war's end in 1865, Peter set up a branch office and showroom in St. Joseph, Mo., a gateway to the expanding West. In 1867, less than ten years after John's return, a year-end inventory listed assets of $223,269.06. At that time the concern had 190 employees. Clem and John decided to take Peter into the firm, so on March 26, 1868, The Studebaker Brothers Manufacturing Company was formed with Clem as president, John as treasurer and Peter as secretary. One of its first actions was to erect a factory consisting of a block-long 4-story structure and a 46x130-foot building three stories high.

About 5000 establishments were then turning out wagons and carriages in the United States. To meet this competition, the brothers made it their first rule to "always give a little more than you promise," and the policy paid off. Sales outlets, or "repositories" as they were then called, were set up in other cities—in New York, Chicago, Dallas, Kansas City, Atlanta and elsewhere. In 1870 the youngest brother, Jacob, entered the business as a salesman. In 1878 Clem went abroad and established several sales agencies.

Sales reached a million dollars in 1875, two million in 1887 and three million in 1898, being aided in the last-listed year by orders from the British and American governments for vehicles for the Boer and Spanish-American wars. On one occasion, 500 wagons were built at the rate of one every three minutes, a creditable performance for that era. By comparison, Studebaker assembly lines can now produce a complete motor vehicle every 50 seconds.

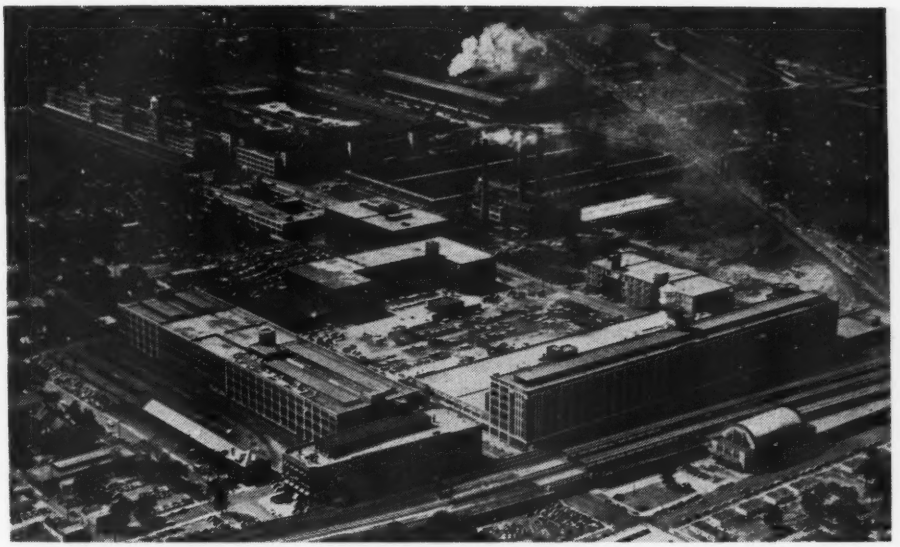
By 1902, when the company was 50 years old, John, or "J.M." as he was better known, was the only one of the brothers still alive. A souvenir anniversary booklet, *A Half-Century of Growth*, recorded that the factory had eleven steam engines of 2500 aggregate horsepower, thirteen dynamos, 235 arc and 1250 incandescent lamps, 312 iron-working and 683 wood-working machines, 6800 feet of line shafting with 2000 pulleys, seven miles of belting and twelve elevators.

On February 12, 1902, the firm sold its first horseless vehicle, an electrically driven runabout, to F. W. Blees of Macon, Mo. Two years later its initial gasoline-powered car was bought by H. D. Johnson, of South Bend. These pioneer automobiles were the result of long planning. As far back as 1895 the board of directors had discussed the idea of getting into the budding new business, and the records show that there were men of vision in the group. Despite the fact that Studebaker wagons were then at the height of their popularity, these men foresaw a bright future for the yet untested self-propelled carriages and began to investigate the possibility of making them. Away from peering eyes, behind a high board fence in the lumber yard and on a specially built boardwalk on the roof of the administration build-

ing, engineers and executives experimented with various types of engines, chassis and bodies.

From 1904 to 1908 the concern marketed the Studebaker-Garford car and then began to distribute the Studebaker-E.M.F. produced by the Everitt-Metzger Flanders Company of Detroit, Mich. Studebaker's world-wide carriage-selling organization gave it a pronounced advantage over its competitors, who had to develop their own means of distribution. By 1910 the management was convinced that the firm's future lay in manufacturing cars, and early in 1911 it formed The Studebaker Corporation to take over the assets of The Studebaker Brothers Company and the E.M.F. Company.

During the automobile's period of incubation, Studebaker continued to build wagons under the watchful eyes of aging J.M., who served as honorary president for several years prior to his death in 1917. He even insisted on inspecting all the lumber destined for use in the old-line product. By 1920, however, it was clear that the days of the horse-drawn vehicle were numbered, and the concern disposed of that phase of its business. All the wagons, carriages and harness made during the preceding 68 years sold for a total of $210 million, or for less than half the 1951 sales. During World War I, Studebaker devoted its facilities largely to filling government orders, but when hostilities ended it was ready with designs of a new line of passenger cars and plans to manufacture them.



MAIN SOUTH BEND FACTORY

The 126-acre establishment where Studebaker passenger cars are built is the biggest industrial plant in South Bend and employs 22,000 in normal times. Occupying a site first visited by the French explorer Father James Marquette, South Bend is a city of 125,000 that has had several names. It was founded by Alexis Coquillard as a trading post for furriers and called Big St. Joseph Station. Then it became, successively, St. Joseph's (it is in St. Joseph County), Southold and, in 1830, South Bend. The name stems from the fact that the St. Joseph River makes a big bend as it flows through the town. Of every 100 residents, 86 are native-born white and eleven are foreign born. A sizable segment of the populace is of Polish extraction. After leaving high school, many of their husky sons find employment at Studebaker, Bendix Aviation Corporation, Oliver Corporation or one of the smaller manufacturing plants. Some of the others cross the city to the Notre Dame campus, and this would at least partially explain why there is usually a liberal sprinkling of Polish names on the renowned "fighting Irish" football teams. The University of Notre Dame du Lac, to give it its full name, has done as much as Studebaker to put South Bend on the map. Established in 1842, it occupies a flat but beautiful campus that includes a brick stadium used exclusively for football. It has around 5000 students and more than 500 faculty members.

SEWING ROOM

The preparation of car upholstery occupies 690 persons, of whom 300 are women. Seven grades of materials, costing up to $15 a yard, are delivered to the cutting room by chutes and elevators. As many as 60 layers are cut at a time with an electrically driven knife after the top piece has been stenciled to serve as a pattern. Then they go to the sewing room to be made into trim panels, seat covers and backs, carpets, etc., with the aid of 140 power-driven sewing machines.

Studebaker survived its greatest financial crisis in the years 1933-35. In 1932, at the nadir of the depression, sales fell off so much that the company lost money for the first time in 80 years. And in March of 1933 the directors, in fairness to creditors, agreed to a receivership. Two young vice-presidents, Harold S. Vance (present board chairman) and Paul G. Hoffman (president 1935-48) were convinced, however, that the firm's troubles were temporary. In view of their boundless confidence the court named them receivers, along with A.G. Bean, president of the White Motor Company, which was 95 percent Studebaker owned.

The three were permitted to run the company on a probationary basis, and their first act was to announce through an advertisement that they were carrying on in the face of all difficulties. They followed this by obtaining a promise from suppliers to wait until cars were sold before requesting payment for the materials in them. As Studebaker was the largest industry in South Bend, the local people were solidly behind the receivers, who resumed factory operations after a shutdown of two weeks, determined to show a profit in the first month. It was

touch and go, but they came out $20,027.62 in the black. On the strength of that showing the creditors agreed to let them continue. After two years they found backers willing to put up the $6.8 million capital needed to float a new company, and on March 8, 1935, a reorganization was effected. Studebaker thereupon became the first automobile manufacturer to come out of receivership after 1490 similar concerns had failed to do so.

South Bend citizens gave Vance and Hoffman a testimonial dinner for saving the city's largest payroll, but some of the new financial backers were extremely doubtful that the danger was over. They questioned whether an independent auto concern, just regaining its feet and still groggy, could muster the strength and the stamina to make any real headway against the firmly entrenched Big Three of the industry. Up to that time Studebaker cars had sold in the medium-price range, but the new pilots figured that they would have to invade the low-price field in order to survive. Risking all their limited capital in an all-out effort, they unveiled the first Studebaker "Champion" in April, 1939.

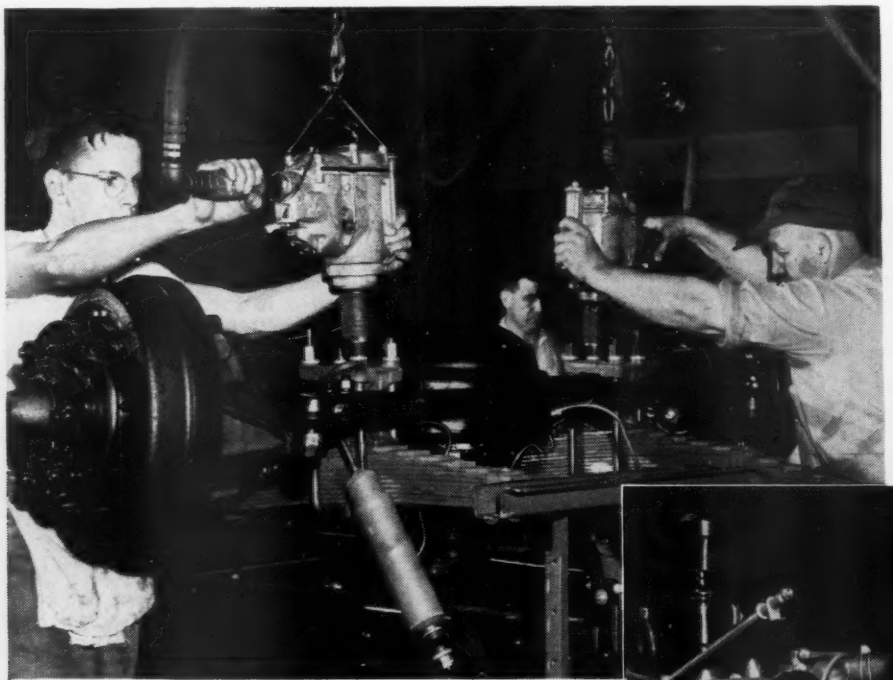
The new model caught on and pulled the company away from the brink of oblivion. Sales mounted from $43 million in 1938 to $81 million in 1939 and $84 million in 1940. Cars were coming off the lines not only in South Bend but also in a Los Angeles assembly plant that had been acquired in 1935. Then came World War II and conversion to military production. For the armed forces Studebaker built 200,000 trucks, 15,000 light tracked vehicles called "Weasels," and 63,789 engines for B-17 bombers.

But soon after fighting ceased the firm was ready with its new streamlined civilian cars that are now familiar to all. Sales zoomed to $267 million in 1947, to $383 million in 1948 and to $473 million in 1949, crossing the half-billion-dollar mark in 1951, the concern's hundredth anniversary. In the peak year of the flourishing 1920's they had amounted to only $177 million.

During its first century, Studebaker manufactured more than seven million highway vehicles ranging from covered wagons to smartly styled autos. Including such incidentals as harness, spare parts, aircraft engines and other materials of war, total sales exceeded six billion dollars. The business that was launched with $68 has paid two billions in wages and $150 million in dividends.

The original brother-owned shop in South Bend has grown into a group of buildings on 125 acres bordering the city's business district. Many are multiple-story structures, and the total floor space is 126 acres, or approximately 5½ million square feet. Only passenger cars and spare parts for them are made in this factory. Trucks come from the outlying government-built plant previously mentioned. Adjacent to it is a new structure devoted exclusively to packaging cars for export. To make sure that they are complete and that they will run satisfactorily when put together, each one is fully assembled and tested and then dismantled for compact packing in boxes. Twelve miles out of South Bend is the 800-acre Studebaker proving ground, where engineers subject new models to all sorts of grueling endurance tests before approving them for regular production.

Like all other automobile manufacturers, Studebaker uses compressed air extensively and in every department. The first compressors ever to serve the plant, five Ingersoll-Rand steam-driven machines that were purchased during 1920-1925, are still in regular daily operation. It would seem that they provide a fairly accurate record of the time when air power was first employed to a considerable extent by motor-car makers. Near these old-timers in the powerhouse is a newer electric-driven unit. From the power plant, the air, at 100-105 psi pressure, is sent out to the various departments through 2 miles of mains. In the foundry are two more large Ingersoll-Rand motor-driven compressors. They have sufficient capacity to serve the foundry's needs but are tied in with the general distribution system. In a few remote places—at the ends of branch lines



ASSEMBLING TRUCKS

Pneumatic tools come into play along virtually the entire assembly line, especially for running nuts, capscrews and other connector elements. They not only contribute importantly to the speed of assembly but also apply the exact force wanted in each instance, with no variation from morning to night. Proper tightening of truck U-bolts and reverse U-bolts is highly important in eliminating spring breakage. Above are pictured two workers simultaneously running ¾-inch hexagonal nuts on U-bolts with Ingersoll-Rand Size 538 impact wrenches. There are eight nuts on a single-wheel assembly and sixteen on a double-wheel assembly. In this application the tools operate against 250 foot-pounds of torque. Each wrench delivers 1200 impacts per minute. The other view shows a smaller impact tool, the Size 504, tightening one of the six ⅜-inch capscrews that hold the engine fan in place.

where so much air is drawn off that the pressure tends to drop—smaller machines are available for use whenever they are required.

In 1951, Studebaker adopted an 8-cylinder engine for its Commander Series, and this, together with increased sales of the entire line, made it necessary to add to the foundry capacity. The new schedule called for a daily output of 400 tons of castings from a plant that had been hard pressed to turn out 200 tons. However, only more equipment had to be provided because the building, with its 13½ acres of floor space, was large enough to meet all needs. One of the principal steps taken was to increase the number of melting cupolas from four to six. Each of these furnaces is 70 feet high, 90 inches in outside diameter and can produce 19 tons of molten metal an hour. The practice is to use three cupolas each day, alternating so that all units get the necessary maintenance every other day. The charges of iron, limestone and coke receive a continuous blast of combustion air from Ingersoll-Rand Motorblowers. There are four of them, each driven by a 100-hp motor and capable of delivering 7800 cfm of air at a pressure of 2 psi.

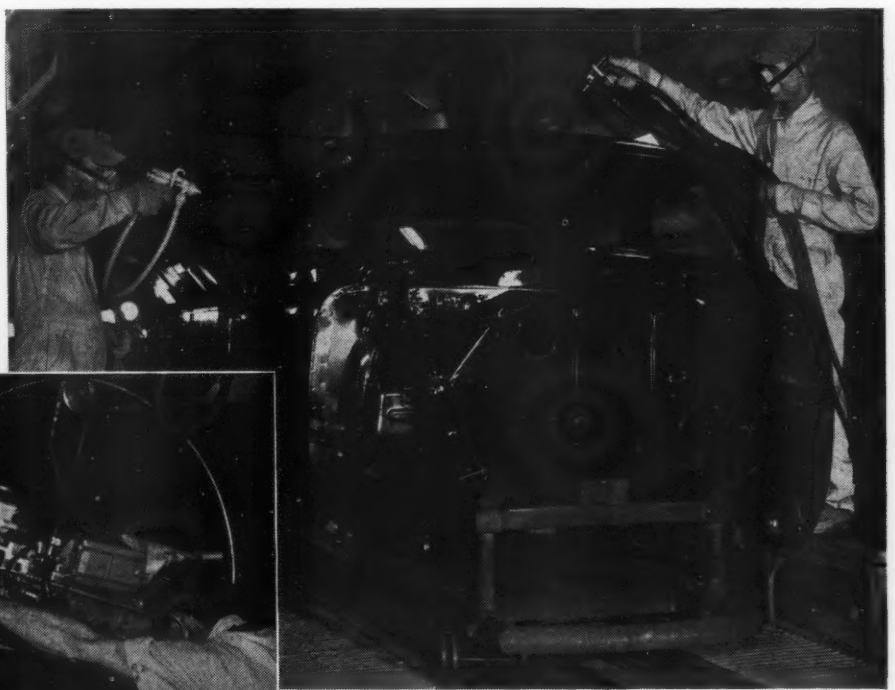
Throughout the foundry, air power performs the customary tasks of operating jolting machines, chipping hammers, grinders and other essential equipment and also serves in at least two interesting ways in the sand-handling department. The quantity of sand in all storage bins is indicated by lights that are controlled by airlevel indicators. A small volume of compressed air is admitted to a chamber that vents into a bin at the control level. When there is enough sand in the bin to cover this vent the air pressure in the chamber rises slightly, thus causing a bellows, mounted at a remote point, to function. Movement of the bellows closes an electrical contact that sends current to the indicating light.

After core sand has been mixed to specifications, it is stored in four 4-compartment bins from which nearby coremaking stations are supplied with sand by a crane operated from a cab and running on a monorail. During the recent expansion of the foundry facilities a section of the coremaking area had to be located as much as 600 feet away from the storage bins, too far to deliver sand by monorail or even belt conveyor. To meet its need, Studebaker engineers developed a pneumatic conveying system.

A batch of sand, ranging from 250 to 1200 pounds, drops by gravity from any one of the sixteen storage compartments into a hopper and thence into a cone-shaped tank or transporter from the bottom of which a 4-inch pipe extends to the coremaking section. As soon as the predetermined amount of sand has been transferred, a swing gate is closed by a pneumatic cylinder to shut off the flow. To send a batch on its way, compressed air is admitted to the cone through four ¾-inch pipes that enter it at different elevations, all below the surface of the sand. As pressure builds up, the sand is forced out of the tank and through the pipe line. The pressure required to convey a 1000-pound batch a distance of 200 feet varies from 25 to 30 psi and to the farthest point, about 630 feet distant, from 40 to 45 psi.

The piping system is arranged so that deliveries can be routed to any one of several stations on a line, as desired. There are four transporters, and all are controlled from one point. The receiving hopper at each coremaking station has an airlevel indicator that signals the control center when sand is needed. Switch gear is then set by the operator, and the required batch is dispatched automatically. Its receipt is acknowledged by a signal from the airlevel indicator.

A modern automobile contains about 5000 different parts made up of some 15,000 separate items. It is one of the marvels of our age that this great miscellany can be brought together as quickly as it is. No less astonishing is the fact that all cars of a given size are more alike than peas in a pod and that any part from any one of them will fit its designed place in all the others. This interchangeability has been brought about by standardization and by the employment of automatic machines that always perform the same operation in the same way. In the actual assembling of the parts the human element comes into play, but even there workmen have acquired skills that enable them to do the job well no matter how many times they have to do it in succession.



SANDING AND PAINTING

After the sheet-steel body skeleton has been fabricated, weldments are smoothed and blemishes removed by successive sandings with belt-type machines (left) in which the abrasive surface moves at a speed of 5700 feet per minute. The dust created is drawn off by a vacuum attachment. Following thorough cleaning, the body is painted (above) with air sprays. Eleven colors are available. Modern heating equipment dries each coat in little more than an hour, in contrast to the weeks that were required for varnish applied to the wagons.

VENERABLE COMPRESSORS

Three steam-driven compressors that have been in service continually since 1923 and 1924. In all, eight large machines feed compressed air into 2 miles of distribution mains. Smaller units are stationed at their extremities.

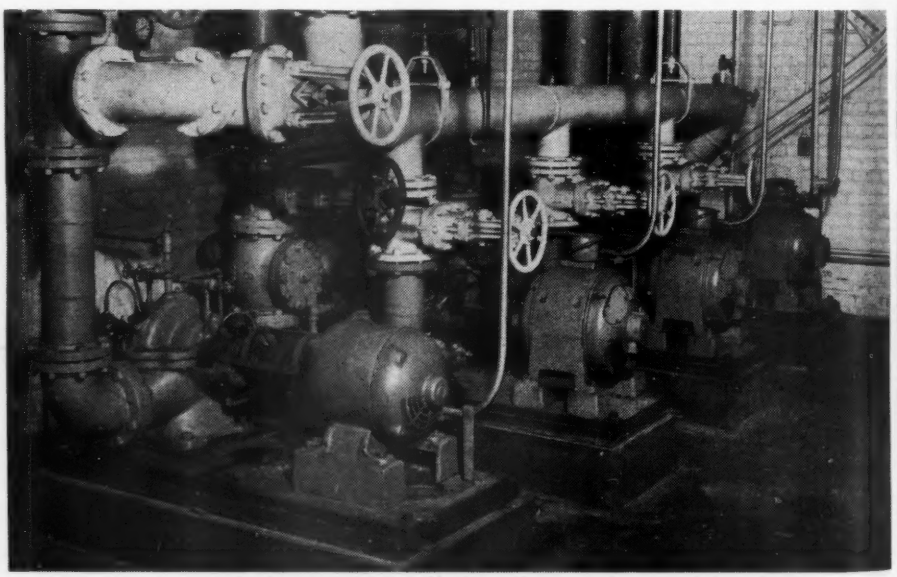
The final assembly line has three main components: The line itself, which is driven at a selected speed by electric motors; air-powered overhead hoists that handle weighty parts as they are added and pneumatic tools such as wrenches and screw drivers that put the parts together; and lift trucks that transport the multitudinous parts to their respective stations along the line. Contributing to the final assembly are, of course, numerous subsidiary operations and subassembly lines. Some of them, such as those for the building of bodies and engines, are sizable departments in themselves and require acres of floor space, thousands of machines, tools and fixtures and hundreds of skilled workmen.

Studebaker manufactures its own bodies, which are composed of some 850 parts obtained from 350 suppliers. Except for four large sheet-metal stampings that come from the Budd Manufacturing Company in Philadelphia, the skin of the body is shaped by 61 presses recently installed at a cost of three million dollars. Held on special fixtures by clamps, many of them air-controlled, the pieces are knit together by spot-welding into eight subassemblies, which are then combined to form a complete body skeleton. After receiving paint, glass and upholstery, it and several companions are transported on a special long-wheel-base semitrailer to the building where cars are assembled.

Engines and other essential parts for passenger cars and trucks are built in a machine shop measuring 882x425 feet. In it is a considerable length of the 30 miles of overhead conveyors in the plant. Much of the work there is done by automatic or semiautomatic machines. Some of them cost nearly $100,000 each. Following accurate surface milling, engine-block castings pass through a succession of machines, including one that simultaneously drills 119 holes in two sides and reams some of them. There are 37 operations on a crankshaft, and any unbalance is automatically indicated and accurately located. It is corrected until it is no greater than the weight of a thin dime at the rotating center. Everywhere quick-acting pneumatic clamps hold pieces in position and hand-wielded pneumatic tools hang from overhead balancers by the hundreds. As soon as an engine is completed, it is run for a quarter of an hour on a dynamometer stand to make the final adjustments.

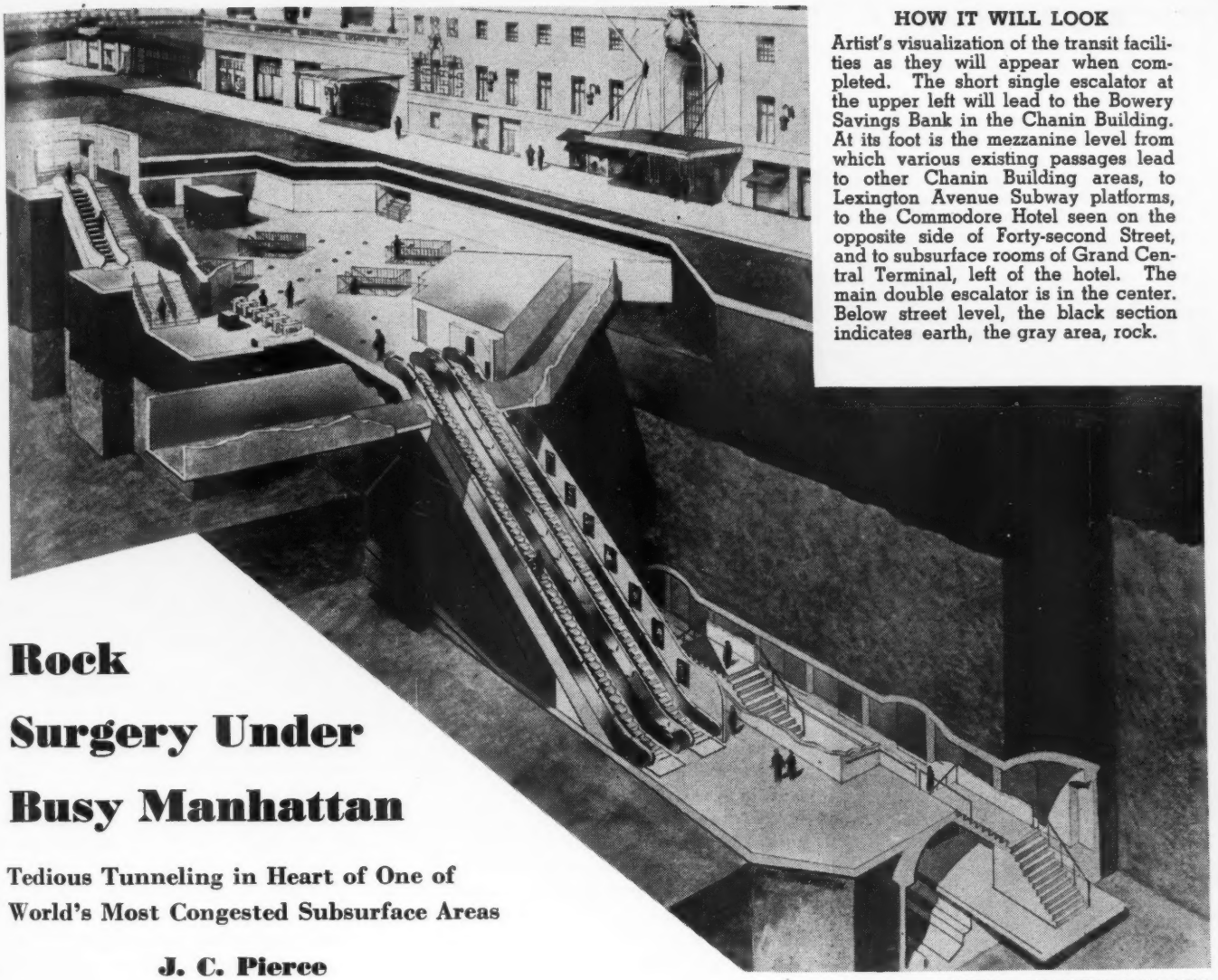
There are two final assembly lines, each 1080 feet long. Feeder lines add 2000 feet more, and in excess of 1000 workmen are involved in all. Starting upside down, the frame progressively acquires front and rear axles and springs, a gasoline tank and other underslung units. Then it is turned over, and the engine arrives by overhead conveyor the instant it is needed. On down the line is the "body drop," where the body is lowered through an opening in the floor and placed on the particular chassis for which it is intended. Next, the front-end assembly—radiator, fenders, headlamps and grille—moves in at right angles on its own line and is attached to the car. Farther along, wheels, bumpers, seats, steering wheel and other components are added; and if everyone has done his part the car reaches the end of the line ready to be driven away. Before it is okayed, however, it passes under trained eyes at various inspection stations and must pass stiff final examinations that cover both mechanical functioning and internal and external appearance.

As it enters its second century, Studebaker can look back on a production of more than seven million vehicles. It is the only concern in the automotive field that has observed a hundredth anniversary. It is the only firm that bridged the gap from horse-drawn to horseless carriages. Having survived 5000 casualties among wagon builders and nearly 1500 among car manufacturers, it promises to live long and prosperously. It is hard to see, though, how the second hundred years can be as eventful and as drama-packed as were the first hundred.



PUMPS SERVING WATER SOFTENER

In producing steam for power generation and other purposes, the powerhouse burns from 500 to 800 tons of coal daily. The current leaves four generators at 13,200 volts and is channeled to 22 substations that reduce it to the various voltages required for different services. A new soda-lime water-softener system has extended the interval of boiler cleaning from every 600 hours to every 1500 hours. Shown are four of a group of Ingersoll-Rand centrifugal pumps that send the water through the equipment.



HOW IT WILL LOOK

Artist's visualization of the transit facilities as they will appear when completed. The short single escalator at the upper left will lead to the Bowery Savings Bank in the Chanin Building. At its foot is the mezzanine level from which various existing passages lead to other Chanin Building areas, to Lexington Avenue Subway platforms, to the Commodore Hotel seen on the opposite side of Forty-second Street, and to subsurface rooms of Grand Central Terminal, left of the hotel. The main double escalator is in the center. Below street level, the black section indicates earth, the gray area, rock.

COURTESY, OTIS ELEVATOR COMPANY

Rock Surgery Under Busy Manhattan

Tedious Tunneling in Heart of One of World's Most Congested Subsurface Areas

J. C. Pierce

MEASURED on the basis of yardage of rock removed, or footage of shaft and tunnel advanced, the excavation being made on New York City's Forty-second Street near Lexington Avenue would be classed as small. But measured by any other yardstick, it is a major undertaking even for that metropolis where difficult subterranean construction jobs are not unique.

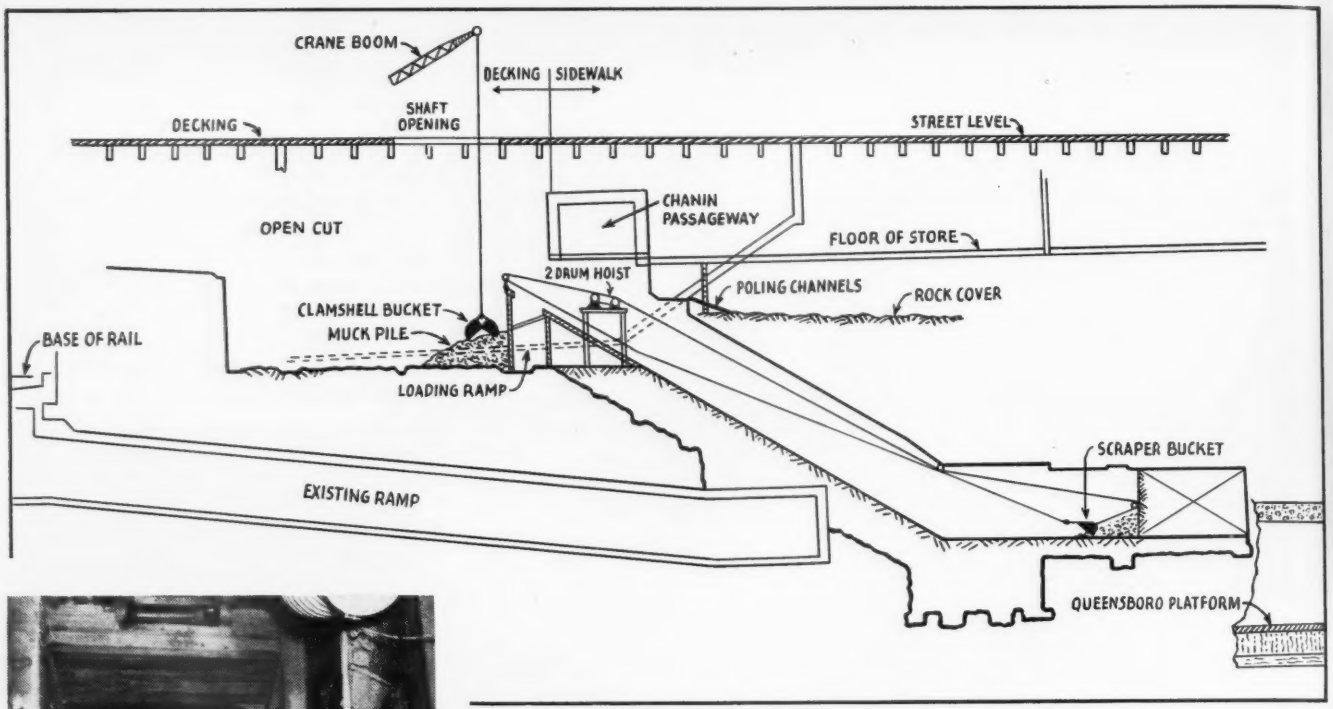
Those who have traveled the subsurface routes in that city in recent years may have come to the conclusion that all the natural earth and stone for about 50 feet under midtown Manhattan has been replaced by steel, concrete and a myriad of utility conduits and pedestrian and rail passageways. But there remains a lot of tough mica schist behind the linings of those underground arteries to support and anchor the structural giants reaching skyward. Some 1600 cubic yards of this rock is now being extracted with a care and skill compared in construction circles with that practiced by a surgeon removing a diseased part of a vital organ.

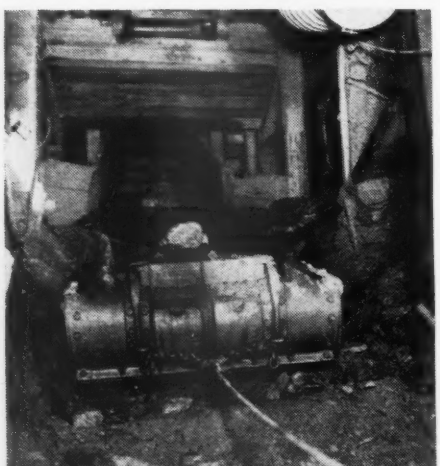
When a traffic bottleneck develops in the subway system of New York, the Board of Transportation is quick to find means of eliminating it. Besides constituting an inconvenience, accompanied by the normal hazards incident to overcrowding, it could result in tragedy in the event an emergency would cause an abnormally large number of pedestrians to surge suddenly toward the area involved. So, in the interest of safety, there should not be a single place in that great interconnected transportation system where the flow of traffic could be unduly impeded.

Such a condition had developed where the Queensboro and Lexington Avenue subway lines converge on Grand Central Terminal. This crossroad is like a point in a river where many streams merge, but where each stream attains flood stage two times every weekday. The existing stairway-ramps and elevator facilities serving the Queensboro level were no longer adequate. Engineers of the Board of Transportation found the answer to the problem in a double escalator that will carry pedestrians to and from the Queensboro Subway platform and the mezzanine level of the Grand Central Terminal where the Lexington Avenue Subway, 40 feet above the Queensboro, also has a station. Pedestrian tunnels from buildings on both sides of Forty-second Street all contribute to the volume of traffic at this confluence.

With an escalator system decided on, the engineers were faced with the major difficulty of fitting the necessary excavation for it and its machinery, together with the access passageways, into an area already congested with tunnels, partitions, building foundations, gas mains, water pipes, sewers, electrical cables, etc. When this was proved feasible on drawing boards, then rigid working specifications were drafted to push the project to completion with a minimum of inconvenience and a maximum of safety to the traveling public and the occupants of nearby structures.

The questionable texture of the rock in the area involved was a matter of great concern. It could not be accurately determined to what extent the formation had been fractured during blasting for the Chanin Building foundation and for the nearby subway tunnels. Unusual occurrences of mud seams and other natural weaknesses in the blocky schist would have to be guarded against and the work carried out at all times with a large factor of safety in order to prevent





HANDLING MUCK

Borrowing an idea from the mining industry, the contractor is moving muck from the inclined-shaft and tunnel excavation up a ramp with a scraper drawn by a hoist mounted at the top of the slope, as shown in the sketch. The spoil is dumped in the open cut and hoisted to street level in a clamshell bucket. At the left is seen a 20-cubic-foot scraper load on its way to the ramp in the background.

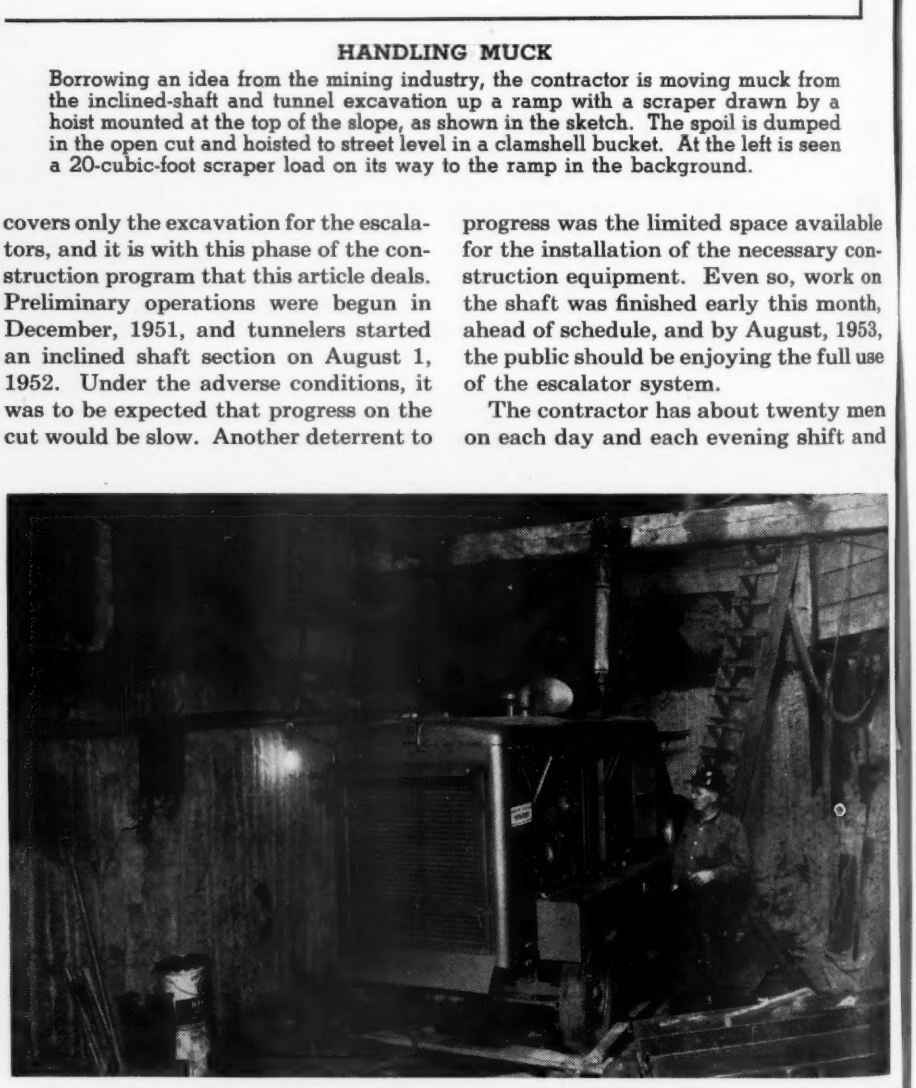
rock movement—any undermining of supports that might cause the street and sidewalks to cave in and damage edifices or sublevel walls.

To avert any unfavorable public reaction, explosives would have to be used sparingly and only a few holes fired simultaneously. In addition to that, blasting would have to be limited to the hours between 10 a.m. and 4 p.m. and again between 7 and 11 p.m. so as not to coincide with peak traffic and to disturb the sleep of guests in nearby hotels.

Labeled as a particularly tough job, it was no accident that Spencer, White & Prentis, Inc., specialists in underground work, was low bidder, for only an experienced firm could tackle a project offering so many hindrances to normal operating procedure. The organization has been in existence for 33 years, and among its noteworthy successes in the eastern United States and Canada are included many of New York's subway jobs and the underpinning of the White House during the extensive work of renovation recently completed.

The Spencer, White & Prentis contract covers only the excavation for the escalators, and it is with this phase of the construction program that this article deals. Preliminary operations were begun in December, 1951, and tunnelers started an inclined shaft section on August 1, 1952. Under the adverse conditions, it was to be expected that progress on the cut would be slow. Another deterrent to progress was the limited space available for the installation of the necessary construction equipment. Even so, work on the shaft was finished early this month, ahead of schedule, and by August, 1953, the public should be enjoying the full use of the escalator system.

The contractor has about twenty men on each day and each evening shift and



SOURCE OF AIR SUPPLY

Compressed air from this Ingersoll-Rand 600-cfm rotary compressor powers drifters, Jackhamers, Jacklegs, paving breakers and the slusher hoist. Exhaust from the compressor's General Motors diesel engine is led upward through the vertical pipe and released about 10 feet above the sidewalk level. The machine is housed in the decked-over open cut.

DRIVING TOP HEADING

View at the face of the 8x9-foot pilot bore at the top center of the horizontal extension of the 18x18-foot inclined shaft. The column and crossbar, as well as the 36-inch shells that carry the Ingersoll-Rand DA-30 drifter drills are made of aluminum for ease of handling. The close spacing of the holes is noticeable, a round consisting of about 56, each 4 feet deep. Only a few were blasted at a time, and then only during certain periods.

is now engaged in driving the tunnel at the foot of the shaft and in digging the approaches. A third crew of about fourteen works from 10 p.m. to 6 a.m. and directs most of its efforts towards cutting niches for supports and removing old masonry to effect a connection with the Queensboro Subway level. The men on the latter shift mix their opprobrious language with words of respect for the workers who, in 1905, hand-mixed and placed the concrete in the walls they are demolishing. They describe the masonry as flint-hard and requiring abnormally close spacing of drill holes to bring it down by the plug-and-feather method. Ingersoll-Rand J-50 Jackhamers on J-3 Jacklegs are used to drill the holes, while L-54 paving breakers are indispensable in breaking out the masonry remaining after primary fracturing. Traffic on the adjacent line of the double-track subway stops while the work of destruction is going on.

In the course of his preliminary planning, the contractor weighed the possibility of starting the excavation on the lower level, utilizing the subway work trains to dispose of the extracted rock in the early morning hours when one-track passenger service is adequate. Normally, it is preferable to drive a bore up a slope, but under the existing conditions that would have inconvenienced both the contractor and the subway system because it would have limited much of the excavating to those few hours each day and thereby postponed completion of the project. Means were found that made it possible to dispense with those muck-handling facilities, and the operations are proceeding satisfactorily from the top downward.

A 50-foot-long, 20-foot-wide hole was cut on the south side of Forty-second Street across from the Commodore Hotel and flush with the curb of the Bowery Savings Bank and adjacent to the ground-level shops of the 700-foot-high Chanin Building. This area was surrounded by a high board fence within which a Manitowoc Model 1500 Speed Crane lifts and lowers materials and equipment from and into the opening, which is decked over with the exception of a 9x15-foot access shaft. Broken rock brought up by the crane is dumped into and hauled by a 10-yard Sterling truck to a barge in the East River, whence it is carried to sea for disposal. From the decking, or street level, the pit was excavated to a depth of 32 feet.

While working downward to bedrock through approximately 20 feet of soil overburden, the diggers had to take every precaution to avoid utility conduits. Piping and cables that were directly in their path and that couldn't be moved to either side of the hole had to be rerouted around the shaft. Earth removal proceeded very slowly at this stage of the operations, and as the men uncovered conduits the necessary adjustments were made by special crews in a manner to prevent service interruptions. At such times 1-cubic-yard buckets were filled by hand shoveling; at others, when there was no danger of damaging utilities, the crane was equipped with a clamshell bucket to bring up the material.

Quarters were too cramped to maneuver a wagon drill in the pit, so Jackhamers were brought into play when rock was encountered to line drill it for blasting with light charges. The uniformly sculptured rock walls forming the bottom 12 feet of the excavation show what can be done with these air-operated tools when handled skillfully and are evidence that the holes were drilled in accordance with the close tolerances specified on this precision job.

The pit, which will ultimately house the machinery that will drive the escalators, served as a station for collaring the inclined shaft, a ticklish job by reason of the undetermined pressure exerted against the top and sides of the opening by the overlying earth and nearby skyscrapers. It also afforded ample space in which to install the portable 600-cfm Gyro-Flo compressor which furnishes air for the entire project. Subsequently, a part of this area was given over to muck-hoisting equipment, and it also provides

DIFFICULTIES ENCOUNTERED

This view of the open cut made in the street to give access to the working area shows some of the obstructions with which the excavators had to cope. Before any concrete and steel member could be removed, it had to be compensated for by strengthening other points. Conduits had to be rerouted. The pile of broken rock is from the inclined shaft and is seen just as it was discharged from a chute behind it for hoisting to street level. The 16-inch Spiratube in the center background exhausts foul air from the shaft, while blowers at the left, beyond the range of the picture, supply the workings with fresh air. The flexible tubing in the foreground carries compressor exhaust gases surfaceward.

temporary storage for the broken rock brought up the shaft. From that point it is picked up by a ¾-yard Owens bucket attached to the crane boom.

As excavated, the escalator shaft, which is on a 30° slope, has a cross section 18 feet square, and it was deemed unwise under existing conditions to mine so large a face at one time. Actually, an 18-foot flat-arch bore such as this one would call for exceptional support even in more secure ground with a more stable overburden. It was therefore decided to advance an 8-foot-wide, 9-foot-high face at the top-center of the proposed cross section, to push this pilot hole downward for a distance of 45 feet, and then to drive it forward as a horizontal tunnel for an additional 40 feet. By this method the diggers could "feel out the ground" safely and provide a space into which the 5-foot wing walls could be blasted. Also, it would permit using light charges to break the rock and, after completion of the top half of the bore, progressive removal of the 9x18-foot bench by drilling down holes with Jackhamers, thus finishing the major part of the excavation work.

For driving the pilot hole in the shaft and tunnel the contractor devised a drill setup that is believed to be unique. It consists of two Ingersoll-Rand DA-30 drifters supported on a 6-foot aluminum crossarm clamped to a 7-foot aluminum column, as shown in an accompanying illustration. This arrangement is effecting appreciable savings in setting-up and taking-down time and is proving satisfactory from every other standpoint. The holes in each wing wall are drilled in the conventional manner with a single machine on an arm supported by a column.

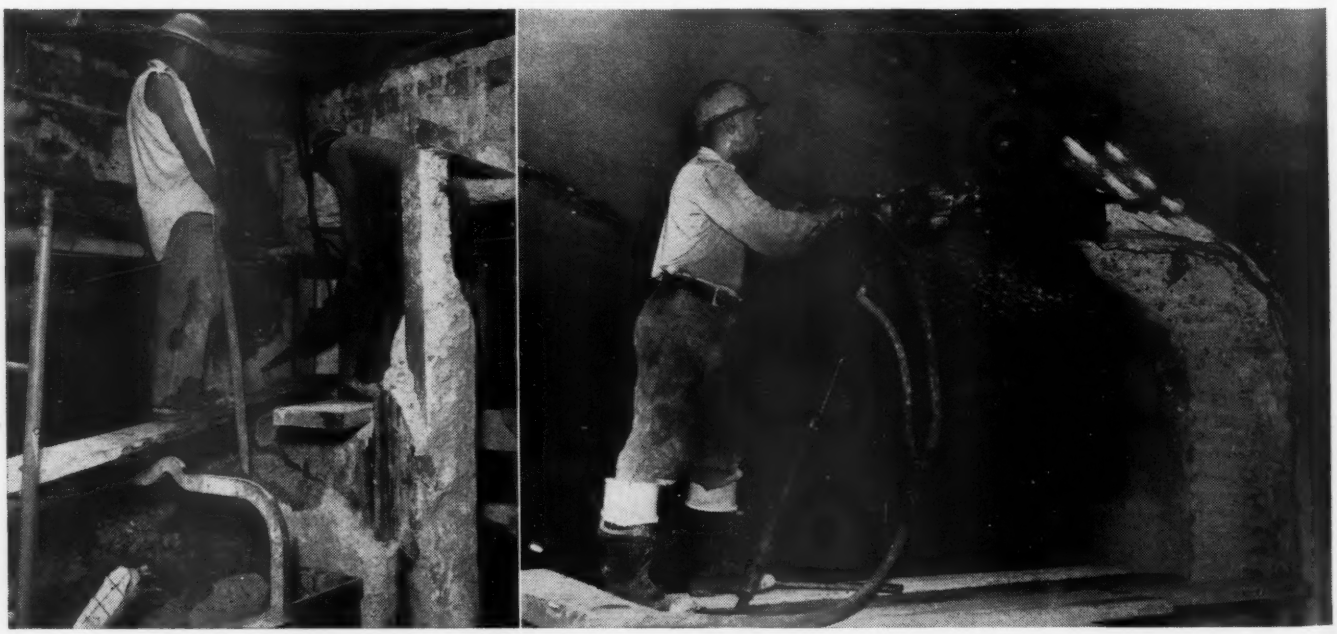
To prevent destructive concussion, a large number of short holes are drilled to permit breaking the ground with light charges of explosives. Forty percent du Pont gelatine dynamite is used and fired with one to four delays. Tungsten-carbide bits are serving well on the job, where the ratio of lineal feet of drill hole to yards of rock broken is necessarily high.

Because it is awkward to muck a shaft on a 30° slope with mechanical loaders of the type employed on less steep grades, the excavators sought other means of removing the spoil after blasting. Spencer, White & Prentis decided that a scraper-hoist arrangement such as they had found effective on previous jobs, could be utilized for the purpose. Studies were made of Ingersoll-Rand scraper hoists working in Mt. Hope (New Jersey) iron mines so that all those connected with the project could familiarize themselves with the technique. An old Lambert 7x10-inch steam pile-driving hoist was mounted on a frame at the upper end of the shaft and is operated by air power to pull a Holcomb Westaco scraper bucket, with a capacity of 20 cubic feet, up a ramp. At the discharge point the scraper dumps its load over a sloping lip, which diverts it to a muck pile at the bottom of the 9x15-foot access shaft.

When Spencer, White & Prentis, Inc., has completed its contract, which includes lining the excavation with steel and concrete and facing it with tiles, the Otis Elevator Company will install two escalators 78 feet 10 inches long. These will travel at two speeds—125 feet per minute during rush hours and 90 in between. Escalators in this country have been restricted to a maximum of 90 fpm, although those in London's subways have operated at 160 fpm for many years. Both of the 4-foot-wide carriers will run up during the morning peak period and down in the evening to handle the homeward-bound crowds. At other times, when traffic is not so heavy, one will go up and the other down. Each will have a capacity of 8000 persons an hour when moving at top speed.

Under a separate contract with the Bowery Savings Bank, Spencer, White & Prentis is excavating a passageway and approaches for a short, single Otis escalator to travel between the mezzanine level of the Grand Central Terminal and the street-level lobby of the bank. It will run at the same speeds as the longer Board of Transportation units and complete the system connecting the street with the Queensboro Subway 65 feet below.

The work is being done under the supervision of the Board of Transportation, of which James H. Griffin is chief engineer. Frank V. Hayes, Emanuel Scheyer and William Marshall are division engineers of construction, design and equipment, respectively. Emanuel Rossum is section engineer. Dan Barrows is project manager for Spencer, White & Prentis, Inc.



CONCRETE DEMOLITION

Tons of concrete and steel were removed from supporting pillars and walls to make way for the new facilities. Much of the work of demolition was necessarily slow and tedious. The view at the left shows a workman tearing out a concrete wall with an I-R paving breaker, while his companion played a stream of water on it at the point of attack to prevent the spread of dust that would have been a source of discomfort to people nearby. In the other picture is a similar tool mounted on a pneumatic Jackleg. It is being used to break concrete by the plug-and-feather method; that is, by driving a pointed steel between two metal strips inserted in a drilled hole.

"Big Tom" Project Nearing Completion

Spectacular Scheme for Transmontane Diversion of Water Was Started in 1939

L. A. Luther

TROUT FISHING IN BIG THOMPSON RIVER

The high-altitude section of the project lies mostly in Rocky Mountain National Park, a mecca for tourists and a sanctuary for wild life. Both the natives and the visitors take their outdoors seriously, and the constructors have been compelled to preserve the scenic features of the region. To make sure that the recreational possibilities of the undertaking would be given due attention, the National Park Service, the Fish and Wildlife Service and Colorado conservation agencies all lent a hand in planning the project.

THE Colorado-Big Thompson Project, a product of bold engineering and a liberal sprinkling of "imagineering," is nearing completion. Although it will not be in full use for a year or two, it has already been dedicated, the ceremony having been moved ahead so as to combine it with the celebration of the fiftieth anniversary of the U.S. Bureau of Reclamation, the agency which sponsored the project. Meanwhile, contractors are at work on the final major features of the multiple-feature undertaking. With about 80 percent of the construction finished, it is estimated that the total cost will approximate $164 million.

The observance of the Bureau's half-century of service was one of several similar programs held during the year in various western areas that have been nurtured by its activities. The one in Colorado was, however, held on the actual anniversary date, June 17. The Bureau started out as the Reclamation Service and was created by an act of Congress signed by President Theodore Roosevelt in 1902. In its 50 years of operation it has been responsible for putting water on six billion acres of land from which half a billion dollars worth of crops are now harvested annually, and for providing in excess of 21 billion kilowatt-hours of electrical energy for farm, home and industrial use. More than 125,000 family-sized farms have been established on the reclaimed land.

Water for irrigation was first delivered under Bureau auspices to the Newlands Project in Nevada on April 1, 1905. The Bureau has sponsored the rearing of some notable dams. Its first one, the Roosevelt in Arizona, was the largest masonry structure in existence when it was dedicated in 1911. A year later, it erected what was then the highest dam, the 354-foot Arrowrock in south-central Idaho. Those structures have long since lost their distinctions, but records are still held by Bureau-sponsored dams—Grand Coulee now being the largest (10 million cubic yards of concrete) and Hoover the highest (726.4 feet).

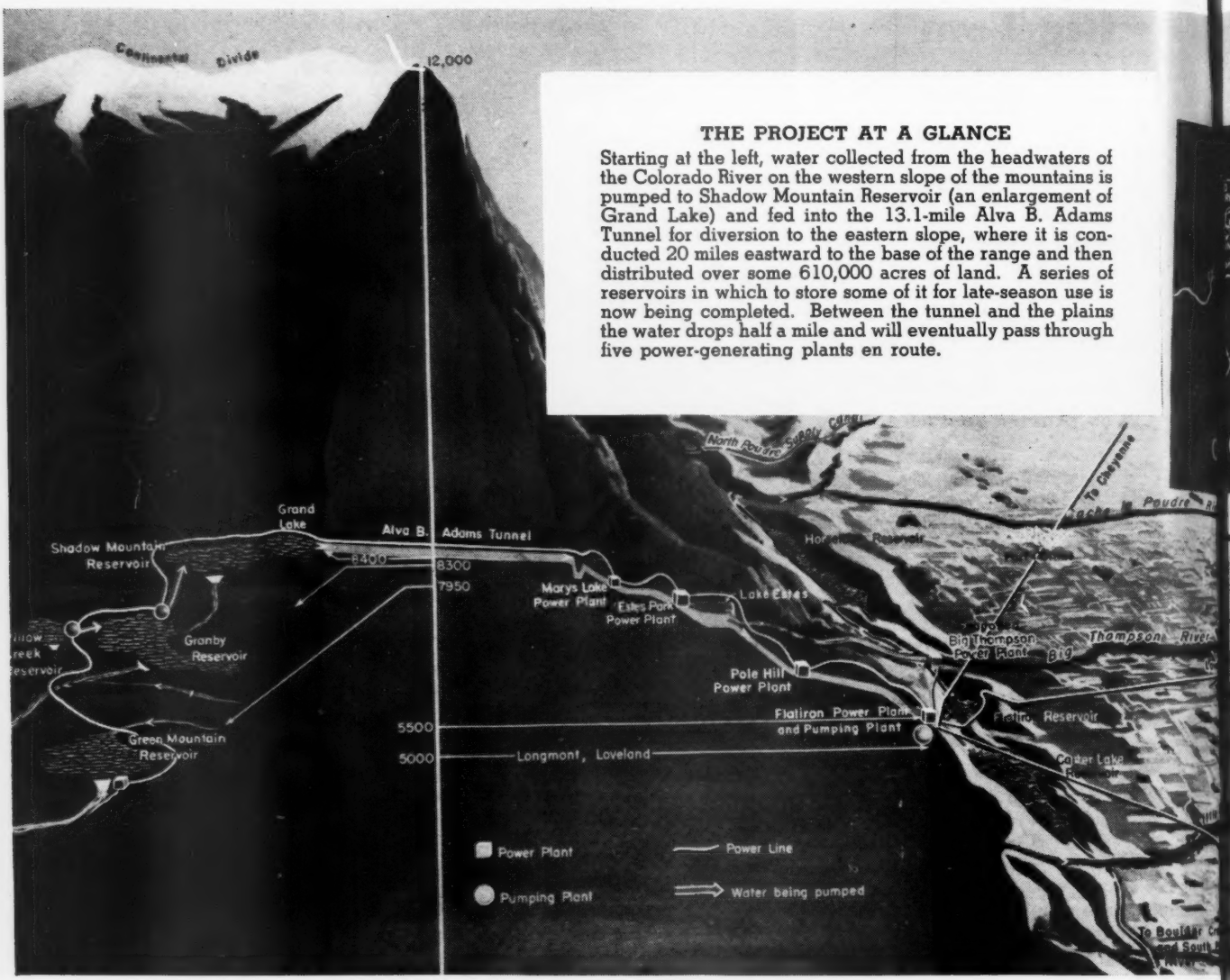
The Bureau was conceived exclusively as an agency for developing and distributing irrigation water, and there was little thought in the beginning of generating electricity. On some of the early projects power was produced for use in dam building and offered for sale after construction was completed. Then came a need for electricity to pump water onto land that was too high to be reached by gravity flow, and hydro plants were included for that purpose in the plans for certain dams.

All the while it was recognized that some of the cost of building dams and canals could be defrayed by incorporating generating stations and selling surplus power. Now, before authorizing construction, the Bureau makes contracts with prospective water users under which the latter repay the cost of the irrigation features over a period of years (usually 40). In some cases, however, it has been realized that those payments would be prohibitive unless some revenue was also received from power sales. Finally, the multiple-purpose project was generally accepted and now commonly includes power generation if there is a market for the current.

The facilities of the Colorado-Big Thompson Project collect most of the runoff from 427 square miles of land on the Pacific slope of the Rocky Mountains and transfer it to the Atlantic side. Nature decreed that this water should flow down the Colorado River, but man has contrived to rearrange the plan the better to serve his needs. Across the Divide to the east there is a lot of fairly level land that is thirsty for more water than Nature gives it. On the other hand, the demands of the mountainous western slope are modest and, after providing for them, there remains an average of 300,000 acre-feet per year that can be diverted. Expressed in more understandable terms, it is equivalent to 98 billion gallons.

The project is intimately connected with the origin of modern irrigation in the Rocky Mountain region. One of the principal cities in the area concerned is Greeley, named for Horace Greeley of "Go west young man" fame. While editor of the *New York Tribune* he sponsored a colonizing group that rode the newly opened Union Pacific extension from Cheyenne, Wyo., into Northern Colorado Territory in 1870 and formed Union Colony. Those men were the real pioneers of irrigation in Colorado and established a pattern for similar coöperative efforts all over the West.

In succeeding years, all of northeastern Colorado's arable land that could be



THE PROJECT AT A GLANCE

Starting at the left, water collected from the headwaters of the Colorado River on the western slope of the mountains is pumped to Shadow Mountain Reservoir (an enlargement of Grand Lake) and fed into the 13.1-mile Alva B. Adams Tunnel for diversion to the eastern slope, where it is conducted 20 miles eastward to the base of the range and then distributed over some 610,000 acres of land. A series of reservoirs in which to store some of it for late-season use is now being completed. Between the tunnel and the plains the water drops half a mile and will eventually pass through five power-generating plants en route.

irrigated readily was settled and canals were constructed to deliver to it all available water from the Poudre, Big Thompson, Little Thompson and St. Vrain rivers and Boulder Creek, all tributaries of the South Platte River. As the maximum runoff is in the spring and early summer, and the greatest need for water is in late summer and fall, reservoirs were built and are filled when water is plentiful and drawn upon when it grows scarce. Over the years, this system, mutually owned by the farmers, has grown to include 120 ditch systems and 60 reservoirs. As a result, more than 700,000 acres have been brought under irrigation.

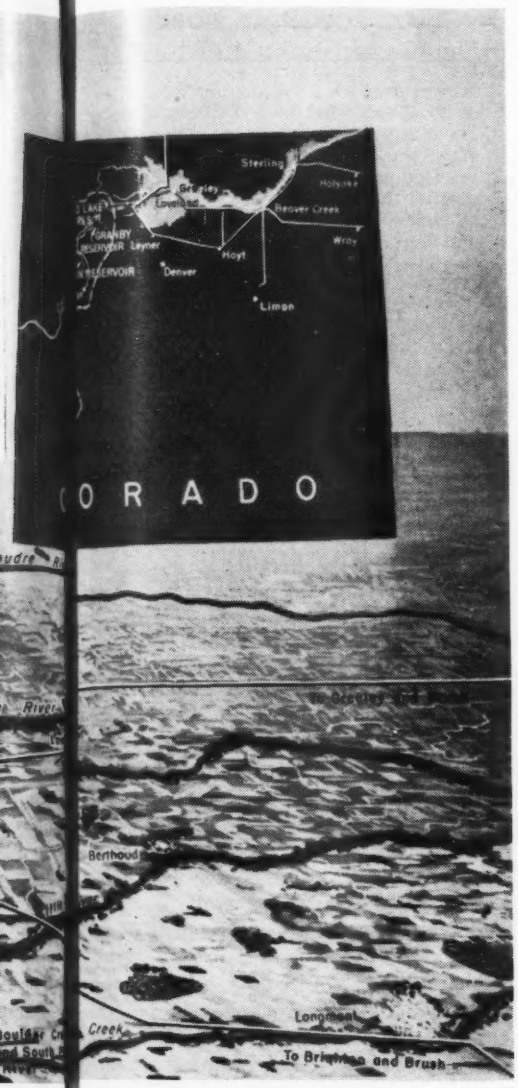
The land has produced abundantly at times but not consistently because some years there has been a deficiency in stream flow. Experts say that about 2½ acre-feet of water should be supplied to each acre for diversified crops and that a large portion of it should be available late in the growing season when crops are maturing. Actually, however, the average water yield over a 10-year period was only 900,000 acre-feet annually, or little more than one acre-foot per acre of irrigated land.

That was the extent of the water supply on the eastern side of the Rockies, but just over the 11,000- to 14,000-foot range to the west there was plenty of it. The reason is that easterly winds colliding with the high peaks drop most of their burden of rain or snow before reaching the eastern slope. The idea of diverting some of the water through the Divide was discussed for years, and as early as 1889 the Colorado Legislature appropriated $25,000 to investigate whether or not it could be done. From then on various plans were put forward, but no serious effort was made to tackle any of them because the task seemed to be too monumental. However, in the depression year of 1933 a group of Greeley men determined to find out once and for all if a practical solution could be found. Led by Charles Hansen, publisher of the *Tribune*, they employed R.J. Tipton to prepare an engineering report on the feasibility of such a venture. His report was presented to Dr. Elwood Mead, then Commissioner of Reclamation in Washington. Doctor Mead, himself a westerner, was receptive to the idea, and on his recommendation Harold L. Ickes, Secretary of the Interior, allotted $150,000 to the Bureau to finance a complete survey.

Based on this survey, the Bureau outlined the scheme as it was later consummated. There followed a long period of meetings with farmers to acquaint them with the plan and of conferences with Colorado's representatives in Congress to get them to work for authorization of the undertaking and appropriation of funds to carry it out. Alva B. Adams was a senator from Colorado at the time, and the tunnel through the Divide now bears his name in recognition of the assistance he rendered.

Eventually, the Northern Colorado Water Conservancy District was organized and a contract with the Government for the construction of the project was drawn up with the provision that $25 million of the cost should be repaid by the water users in 40 equal annual installments. An election was held at which 8000 landowners voted almost unanimously to uphold the contract. With these preliminaries out of the way, Congress appropriated funds to begin operations, and the first contracts were awarded in November, 1938.

Most spectacular of the diversified works is the 13.1-mile concrete-lined, 9-



BALD MOUNTAIN TUNNELERS

Below, looking toward the tunnel face along the top deck of the drill carriage. Two of five Ingersoll-Rand DA-30 drifter drills are shown. The bore, which will be a part of the pressure system to carry water to the Flatiron Power Plant under 1100 feet of head, has been holed through and is now being lined with concrete. It will have a finished diameter of 10½ feet.

foot-9-inch-diameter tunnel through the upper reaches of the Continental Divide that is hailed as the longest ever driven to carry water for irrigation purposes and the longest ever advanced from only two headings. In addition, there are 23 other tunnels of assorted bores and lengths, plus fifteen dams, ten reservoirs, sixteen siphons and eleven canals that will impound, store and distribute water vitally needed for crop raising. When fully developed, the scheme will also include six hydroelectric plants, 785 miles of transmission lines and 36 substations and switchyards.

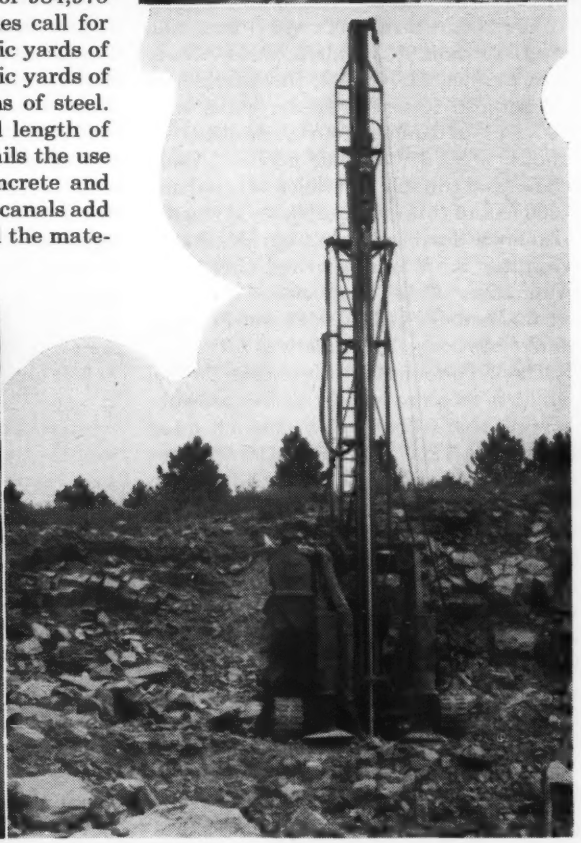
Because it embodies so many elements, the project may appear to be complicated, but when it is looked at, part by part, it becomes easy to understand. First, the water is collected and stored in reservoirs on the western slope. Then it is pumped to an elevation from which it flows by gravity into the transmontane tunnel, which is the key feature. From the eastern end of the tunnel the water drops half a mile in traveling 20 miles to the edge of the plains, and this falling force or head will be used to generate electricity. When it reaches the foothills it will be conveyed to storage reservoirs and held until it is needed for irrigation purposes. Finally, there are transmission lines to deliver the electricity to points of use. One section of the line passes through the Divide in the Alva B. Adams Tunnel.

Construction figures compiled in accomplishing all these things are impressive. The reservoirs and regulating basins have a combined area of 14,960 acres and a storage capacity of 984,975 acre-feet. The dams and dikes call for the handling of 23 million cubic yards of earth and rock fill, 52,000 cubic yards of concrete and nearly 2500 tons of steel. The tunnels have a combined length of 35 miles, and their lining entails the use of 336,700 cubic yards of concrete and 5600 tons of steel. The eleven canals add up to 93 miles. Aside from all the materials and equipment involved, it is estimated that 40 million man-hours of labor will have been expended by the time the job is finished. Peak employment of 2892 persons was reached in August, 1947.

The work now underway is spread along the eastern base of the range and

QUARRYMASTER AND BIT

The self-contained, deep-hole drilling machine, bottom picture, divides its time between two quarries that furnish stone for use in three Carter Lake Reservoir dams. It puts down 5½-inch holes to depths of from 14 to 33 feet. The Carset bits used with it average about 2000 feet of hole and are normally resharpened three times with an air-operated hand grinder, as shown directly below.



AIR POWER AT WORK

The Winston workman pictured at the left is sandblasting a concrete surface to prepare it for another pour. Air is being supplied by a 210-cfm Gyro-Flo rotary air compressor. The other view shows a backfill tamper being used by an Adler employee to consolidate earth adjacent to the concrete cut-off wall of Rattlesnake Dam.

has to do with the completion of the system that will distribute water to the storage reservoirs and the two lower powerhouses. To carry it around and through natural obstacles it was necessary to build conduits, canals, siphons and tunnels. The remainder of this article deals with some of these construction features that are being executed by two contractors—Winston Bros Company, of Minneapolis, Minn., and Adler Construction Company, of Loveland, Colo.

Winston started work July 10, 1950, on contracts totaling $11,500,000. These include: Carter Lake Reservoir with three dams and appurtenant features, $2,400,000; Flatiron Power Plant and afterbay dam, $2,300,000; Bald Mountain Tunnel, $1,700,000; three-mile-long Horsetooth Reservoir feeder canal with 600 feet of tunnel, four monolithic siphons, etc., $1,200,000; and St. Vrain Canal and tunnels (8.4 miles of canal and 4200 feet of tunnel), $2,300,000. Winston also holds a subcontract from Southwest Welding & Manufacturing Company, Alhambra, Calif., in connection with steel penstocks at Pole Hill and Flatiron power stations, $1,200,000.

The 6700-foot Bald Mountain Tunnel which is to serve as part of the pressure conduit that will bring water at a head of more than 1100 feet to Flatiron Power Plant has been driven, and the 13-inch concrete lining to give it a 10½-foot internal diameter is being placed with an air-powered Kemper gun. This bore was advanced from one heading, using a carriage having four Ingersoll-Rand DA-30 drifters mounted on the front and one as a tail machine. Rounds ranging from 8 to 9 feet were drilled with 1½-inch Carset detachable bits on 1⅛-inch steel. These bits, sharpened an average of three times, averaged 245 feet of hole each. The rock encountered included basalt, granite, gneiss and schist. Three shifts pushed the heading forward an average of 40 feet per day.

Excavating and concrete placement are underway on foundations for the penstocks that will connect with the lower end of Bald Mountain Tunnel and carry water down to Flatiron Power Plant, where Winston has field offices and where a concrete building has been erected to house its main dispatching headquarters. Penstocks are being placed by Southwest Welding & Manufacturing, and similar work is in progress at the Pole Hill Power Plant, which is the next one above Flatiron. Winston is using an R-600 Gyro-Flo rotary compressor to supply air for digging the penstock foundations and for other needs at Pole Hill. An identical machine supplements the main stationary compressor plant at the Flatiron power site and serves Bald Mountain Tunnel through a pipe line.

Drilling with FM-2 wagon drills for excavations from which to open headings for driving 4200 feet of St. Vrain tunnels has been completed, and an R-600 compressor that was furnishing air for the purpose has been shifted to operate Jackhamers on the Carter Lake Reservoir outlet works. An R-315 compressor is serving drills and compaction tools on the St. Vrain Canal. The work on the contract covering the Horsetooth Reservoir feeder canal and its siphons and culverts is generally similar to that on the longer St. Vrain conduit. Air for operating wagon drills and lesser tools on the Horsetooth job is supplied by an R-600 and an R-315.

Carter Lake Reservoir, at Elevation 5759, is the largest (112,000 acre-feet) eastern-slope catchment. It is being formed by constructing three earth-and-rock-fill dams to seal gaps between hills and thus enclose a natural basin. The biggest of these, designated as No. 1, closes the drainage outlet and requires 2,525,000 cubic yards of material. The two lesser barriers are virtually finished, and No. 1 begins to approach its final 1235-foot length and 200-foot height. Earth, to be compacted with heavy sheep's-foot rollers to form the central core of the dam, is being hauled with Euclid scrapers from areas of the reservoir floor chosen by the Bureau.

The large quantity of riprap and lesser amount of rock needed for the three dams is being obtained from two quarries, one ¼ mile from No. 1 Dam and the other about a mile away. Some use was made of wagon drills in the first phase of quarry development, but at the present time, as during most of the production period, drilling in both quarries is being done entirely with one Ingersoll-Rand Quarrymaster, which is moved between sites as required. This big, crawler-mounted reciprocating drill was bought by Winston in 1947 and used at Tahawus, N.Y., for stripping overburden from a titanium deposit.

Holes drilled by the Quarrymaster range in depth from 14 to 33 feet and are loaded with Dupont 40-percent special gelatine. A 2½-cubic-yard Northwest shovel in each quarry loads into nine Euclids, six of which are equipped with sideboards to handle about 17 cubic yards. As rock is dumped along the faces of the dams, selective placing of heavy riprap is accomplished by bulldozing it into position with Caterpillar tractors with toothed rakes. Two 10-hour shifts are being worked on rock haulage, and the Quarrymaster, operated by a driller and an oiler, is on a 3-shift schedule. The

5½-inch Carset bits used average 2000 feet of hole each and are sharpened about three times with an air-driven hand-held grinder. Many bits show no breakage after all this service and are retired on account of lost gauge, but they will be resized and used on extension drilling. It is estimated that the work done by this drill in the two quarries is equivalent in effect to that of eight wagon drills on the same 3-shift schedule. Air for operating compaction tools on the dams, for sandblasting, etc., is supplied by an R-210 Gyro-Flo compressor.

F. G. Peterson is project manager for Winston Bros Company, R. L. Wahl is office manager and Roy Shriner is master mechanic. The following serve as superintendents: Archie L. Turnbull, Carter Lake Reservoir (recently succeeded Glenn MacAfee who was transferred to Nimbus Dam); Al Costner, Horsetooth Reservoir feeder canal; R. P. King, St. Vrain Canal; C.W. Bingham, steel penstock erection; James Wren, Flatiron Power Plant and afterbay dam; and Frank (Slim) Merrick, tunnels.

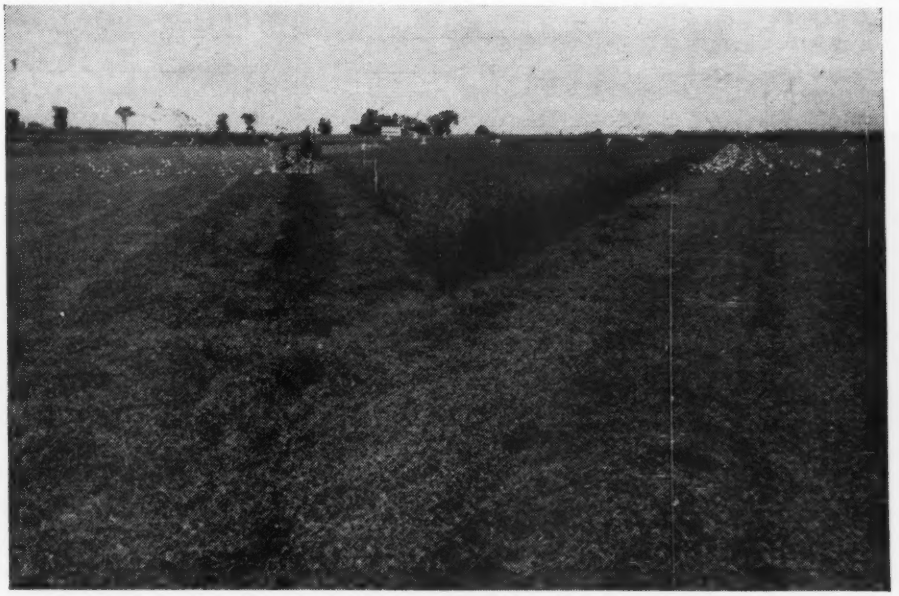
Adler Construction Company, Loveland, Colo., is working on four elements of the project on which their successful bids represent a total of more than $3,000,000: Pole Hill Power Plant, $1,000,000; Rattlesnake Dam, $850,000; North Poudre Supply Canal, $800,000; and St. Vrain siphons, $390,000.

Rattlesnake Dam will be a conventional earth-and-rock-fill structure typical of other dams designed by the Bureau for this project. It will be 125 feet high, 1300 feet long, 30 feet wide at the crest and 595 feet at the base, with a central concrete cutoff wall keyed into rock footings. The footings adjacent to the wall have been pressure grouted to depths of 100 feet. The dam will consist of a central core composed of 500,000 cubic yards of earth and rock, of a so-called Zone-2A of tunnel waste upstream from the core, of 30,000 cubic yards of quarried riprap to form a 6-foot-thick face on the upstream slope and of 116,000 cubic yards of quarry rock to be placed downstream from the central core.

Suitable earth for the core is being obtained from pits close to the site and is being handled with seven Wooldridge Terracobras. Riprap is quarried about 6/10 mile from the dam with three wagon drills operated by an R-600 compressor and loaded by a 2-yard Lima shovel into four 15-ton Euclids. A second R-600 utilized by Adler to power wagon drills, Jackhamers, paving breakers, etc., in excavating for the dam and spillway makes a total of ten Gyro-Flo portables on the project, with an aggregate capacity of 5000 cfm. The fact that seven of them are of 600-cfm size is proof that the construction industry looks with favor upon a compressor that compares well with many stationary machines in air output and yet is mobile enough to be towed quickly to any point where a fairly large volume of air is needed.

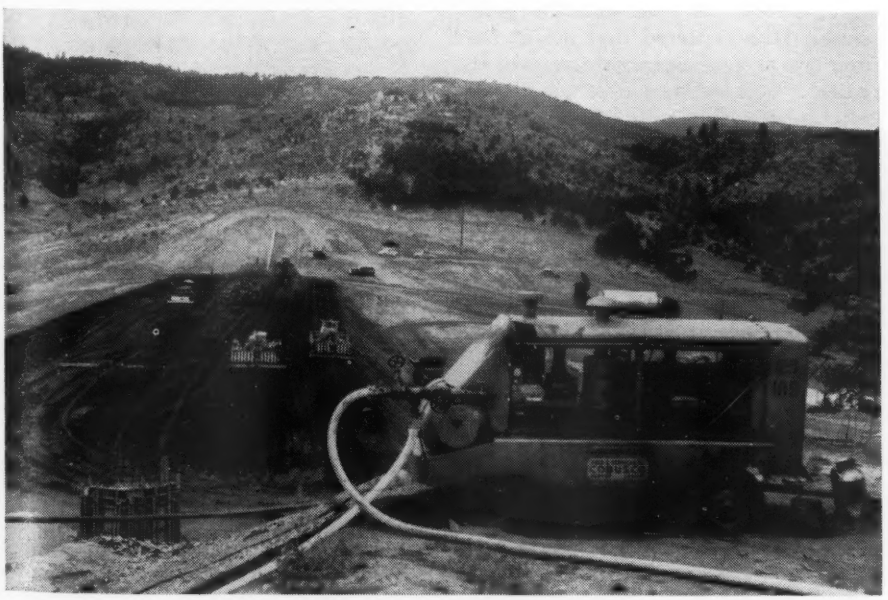
Harold C. Adler, a partner in the firm, is in charge of field operations and states that work on all four jobs, some of which are 20 miles apart, is carried out on a one-shift schedule. The concern has 200 pieces of equipment and currently employs 270 men. A.B. Farnworth is superintendent on Rattlesnake Dam; Nolan Wallace is superintendent at Pole Hill Power Plant; and O.A. Moore is superintendent on North Poudre Supply Canal.

The Bureau of Reclamation maintains a field laboratory, and its engineering personnel follows every phase of construction. Work on the project is under the direction of J.H. Knights, district manager, South Platte River District, Region 7, with headquarters in Denver, Colo. Charles P. Segers is district engineer and George H. Highley is construction engineer with headquarters in Loveland. Michael W. Straus, Washington, D.C., is commissioner of the Bureau of Reclamation. The chief engineer and director of the design and construction division is L.N. McClellan, whose offices are in Denver.



SEAGULLS WITHOUT A SEA

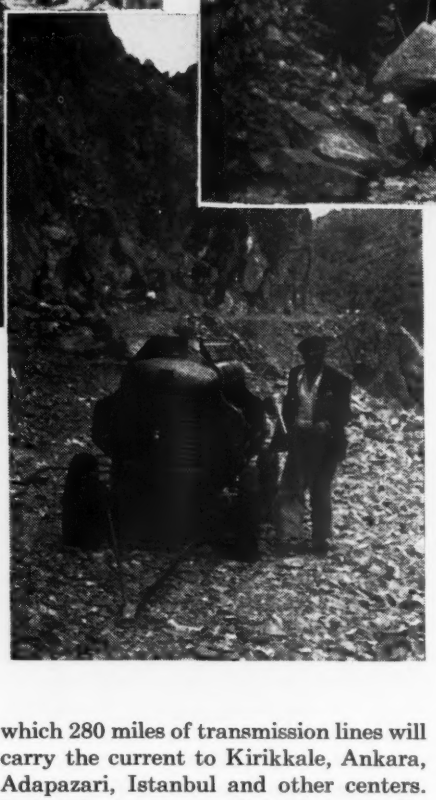
On the irrigated farms of the region, a thousand miles from a seaport, are many gulls. Flocks of them follow the mowers and rakes in the alfalfa fields and gorge themselves on grasshoppers. Some people believe they are descended from the Great Salt Lake gulls that befriended the early Mormons.



RATTLESNAKE DAM

Earth-moving machinery and sheep's-foot rollers at work on a half-million-cubic-yard barrier being built by Adler Construction Company. In the foreground is an Ingersoll-Rand 600-cfm rotary-type portable air compressor.

An American Engineer Abroad



ROAD BUILDING

When Mr. Becker came across an Ingersoll-Rand portable air compressor being "gassed up" by a native (right), he recalled that the machines are built at Painted Post, N.Y., not far from his home in Livonia in the same state. Forthwith, he sent a picture of it to the factory, with a letter telling about its service. The compressor was furnishing air for a Jackhamer crew perched precariously on a cliffside (above) during the construction of an access road to a dam site near Sariyar.

SECONDARY "BLASTING" CREW

Because of the high price of dynamite, the roadbuilding contractor elected to employ sledge swingers (above) to break up boulders that were too large for loading after primary blasting had taken place.

A YANKEE construction man in Turkey finds the country lacking in many of the comfort-giving facilities that abound in America but thinks their absence is offset by the sincerity and courtesy of the people. Such is the impression of Gordon C. Becker, who has been doing engineering work there in connection with a sizable hydroelectric development. Mr. Becker, who previously worked on the Alcan Highway between Edmonton, Canada, and Fairbanks, Alaska, went to Turkey in March, 1951, as a representative of Charles T. Main, Boston consulting engineer.

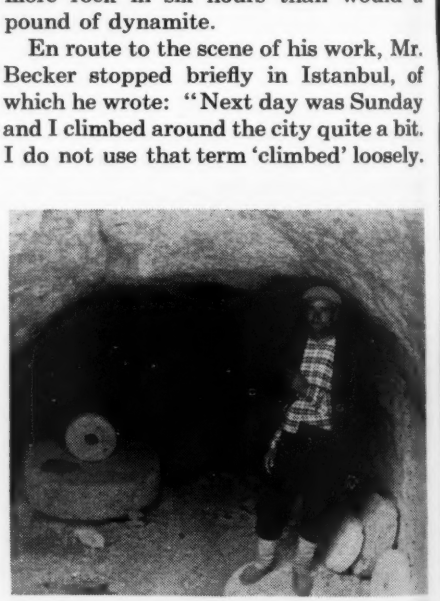
The power plant is being constructed on the Ayman Plain in northwest Turkey, about 110 miles east of Ankara, the capital. Under the direction of Etibank, an agency of the Turkish Government, a rock-fill, concrete-core dam is being thrown across the Sakarya River near the town of Sariyar. Impounded water will be directed through a tunnel 4000 feet long and 30 feet in diameter to the station, where turbines aggregating 130,000 hp will drive generators with a capacity of 80,000 kw.

Mr. Becker's main job initially was to conduct a survey of the routes over which 280 miles of transmission lines will carry the current to Kirikkale, Ankara, Adapazari, Istanbul and other centers. Industries to be served include steel mills situated about 200 miles from the powerhouse. It is expected that it will take from two to four years to complete the project. Because the site of the plant is many miles from a railroad or good harbor, the problem of hauling in turbines, generators and other equipment will be a serious one.

Etibank received two bids on all the estimated $25,000,000 of construction involved, but both were rejected for various reasons and the work was broken down into several sections. A Turkish firm bid low on the tunneling work. At first it was planned to drive two large-diameter bores to carry off the water discharged from the turbines, but it was later decided to change to open channels. One of the peculiar features of the tunnel contract is that the contractor will have to make his own sand for concrete by crushing rock.

Accompanying pictures show operations on 15 miles of access roads around the dam site. This was being handled by a Turkish concern with a labor force of 500. Compressed air, mechanical rock drills and explosives were used for the primary dislodgment of the rock, but secondary breakage of pieces too large for loading was done with sledge hammers. Dynamite costs 90 cents a pound delivered, and laborers are paid fifteen cents an hour. The Turkish way of figuring it was that a man could break more rock in six hours than would a pound of dynamite.

En route to the scene of his work, Mr. Becker stopped briefly in Istanbul, of which he wrote: "Next day was Sunday and I climbed around the city quite a bit. I do not use that term 'climbed' loosely.



MILLSTONES TO ORDER

Entrance to a Turkish underground quarry showing millstones ready for delivery to customers. These grindstones (the larger ones are more than 3 feet in diameter and 10 to 12 inches thick) are cut around the perimeter and the center hole is put in each before it is broken loose from the parent formation. The buyer accepts them at the quarry and gets them down the mountainside at his own risk.

The city is one series of steps after another. From the waterfront to the main street there are 456 steps, all at least 10 inches high." Ankara, too, is of step-ladder construction, he reports. In the office building in that city where he makes his headquarters there is a one-way elevator—it works only going up. To get it down you have to ring on the ground floor. (The Turkish Information Office in New York explains that this is the practice in some buildings that are not more than three or four stories high. The theory is that it reduces wear and tear on elevators and that it imposes no great hardship on people to walk downstairs.)

Ankara, Mr. Becker relates, grew rapidly after it was made the capital of the new republic following the War of Independence that resulted in the overthrow of the sultanate in 1923. This called for new streets, new buildings, etc., and much construction was undertaken. But nobody thought of sewers until all the other improvements had been made. Then the streets were torn up and sewers were put in. Another thing the planners overlooked was water mains. Now, about twenty pieces of equipment, including fifteen tanks of water, turn out when there is a fire. Fortunately, there are not many, because substantially all structures are of stone, clay or concrete and there is little to burn.

In the course of his transmission-line reconnaissance Mr. Becker stayed for some time in the typical small town of Mudurnu, and it was there that he first gained an insight into the many commendable qualities of the Turkish people. "Mudurnu," he writes, "is a village of about 3500 people—all men, I guess, I never saw a woman. It has no water system, no fire department, no sewage, no Rotary Club, no Elks Lodge. It has five automobiles, two street cleaners, one doctor, one lawyer. The main industries are making shoes and copper articles of many kinds and breeding horses, donkeys, oxen and water buffalo. There are also several olive and poppy-seed oil-extraction plants.

AHMET AND ALLAH THRESHING COMBINE

No compressed air used here. Ahmet tosses the grain into the air and Allah furnishes the wind to separate the chaff (note cloud at right).

RUTS OF TIME

A stretch of roadway near Akyasi that is reported to have been in continual use for 4000 years.

"The village is not on our line, but we made headquarters there because it has a hotel—an old building of three rooms, an office and two bedrooms. In one room are six beds and in the other, used by my interpreter and myself, two. There is no bath in the hotel, but a Turkish bath, which is said to be 600 years old, is next door.

"Hotel rates are quite reasonable in Mudurnu—one lira (36 cents) per day. The owner is desk clerk, bellboy, chambermaid, purchasing agent and cashier. If the hotel is full, he can take in $2.88 a day, but never were more than five guests there during my seventeen days' stay.

"One thing Mudurnu has is electricity. A water-powered turbine is used during the day and a diesel outfit for 'heavy loads' at night. One generates 30 kilowatts and the other 48. Imagine that amount of current for 3500 people! The room I occupied has one 10-watt bulb in it. The hotel is clean and you are permitted to cook in it, for the town has no restaurants.

"The thoughtfulness of the natives and their genuine politeness and sincerity more than offset the inconveniences. I have gone over 280 miles of line, which meant much walking. I have been in their villages, eaten with them, tried to converse with them, etc. The peasants are hard workers, thrifty and honest, and consider it an honor to guide you 10 kilometers (6.2 miles) on foot. To offer them pay is an insult."

OXDRAWN "EXPRESS"

In this highway caravan were 31 teams of oxen hauling railroad ties. The average load was seven ties per vehicle, but one carrying twelve was observed.

Alcan Tunnelers Set New Record

MECHANICS AND "BULL GANG"

The men who keep the equipment functioning and the track laid to the heading are standing in front of the air compressors that supply power for the drills and mucking machine. The portal is at an altitude of 2600 feet on a mountain.

NEW records for advancing a large-diameter tunnel in rock have been established on the Alcan (Aluminum Company of Canada) Project in British Columbia, which was described in our August, September and October issues. Drilling crews of the principal contractor, Morrison-Knudsen Company of Canada Limited, eclipsed existing daily, weekly and monthly progress marks for a 25-foot bore.

Working nearly a mile in from the western or discharge end of the 10-mile tunnel that will convey water from Lake Tahtsa to the intakes of the Kemano Powerhouse penstocks, the crews have been setting new figures and then surpassing them during the past two months. For that reason, while the performances recorded here are the best that had been reported at the time of writing, they may have been exceeded since the news about them came to hand.

Morrison-Knudsen tunnelers knew they were making good headway and began looking up the records back in September to see how they were doing by comparison. At the end of the third shift on September 27 they claimed a new high of 248 feet in six days. This exceeded the best previous advance for a bore of comparable size by 7 feet. The old mark, curiously enough, was also established by Morrison-Knudsen crews working under Supt. Carl J. Herslof in the power tunnel of the Big Creek No. 4 Dam in California in December, 1949. The new record stood only until October 25, when an advance of 258 feet was reported for the preceding six days. The following week, ending November 1, that

SUPERVISORS AND VISITORS

Shown at the tunnel portal, left to right: Jake Smith, master mechanic; Joe Black, resident engineer for British Columbia International Engineering; R. E. Davis, general tunnel superintendent; Ray Reed, area engineer; H.W. Morrison, president of Morrison-Knudsen Company, Inc.; R.H. Madsen, assistant project manager; W. Hostetter, tunnel superintendent; James P. Growdon, visiting consulting engineer; W. Bear and Pat O'Dowd, walking bosses; John McNamara, G. Belhumuer and C. Chase, shift bosses; A.O. Strandberg, project manager; G. Griffin, Seattle manager for Morrison-Knudsen; S.L. Williams, night tunnel foreman. More than 130 men are engaged in the 3-shift operations.

figure was surpassed, the last one being 261 feet, or a daily average of 43.5 feet.

During the month ending November 1, the heading was pushed forward 1073 feet, which is 75 feet more than the best progress at Big Creek No. 4. Because October 13, Thanksgiving Day in Canada, was a holiday for the tunnelers, their new mark was made in 26 working days, compared with 27 at Big Creek. During the October splurge, an advance of 54 feet in one 24-hour period was achieved, and this is concededly better than the best day's performance at Big Creek, which is not clearly recorded but seems to have been under 45 feet.

As has been pointed out before in these pages, all statements regarding tunneling records have to be qualified because of the wide variation in tunneling conditions. For example, the highest speed can normally be made in a bore that is just large enough for men and machines to work in conveniently. As the cross section increases, more holes have to be drilled and more rock broken, loaded and hauled, and progress necessarily becomes slower. It is obvious, then, that comparisons mean nothing unless they refer to tunnels in the same size range.

Aside from this point, the rate of advance in any tunnel is greatly affected by the character of the rock, which includes such factors as how it drills, breaks and stands without support. However, as the diameters of the Kemano and Big Creek tunnels are about the same, Kemano in fact being one foot larger, the comparison is in order. As regards rock, that encountered at the Kemano heading where the records were made is reported to be more difficult to handle than that at some of the three other headings in the same bore. The drillers, who made the high marks, call it the hardest on the whole job.

Drilling equipment in the heading concerned consists of sixteen power-feed, aluminum-shell drifters mounted on a conventional platform-type carriage. Fifteen machines are at the front end of the structure and one is at the back. Top-deck drills are on individual booms for easy maneuverability. The actual drilling elements are 4-point-type tungsten-carbide-insert detachable bits of 2-inch gauge. It is of interest to note that during the record-day advance of 54 feet approximately 6000 feet of hole was drilled. Under such conditions all equipment involved is obviously put to a severe test. Mucking in the heading is done with Conway loaders.

Drilling at the heading was begun last February, and on October 15 the 5000-foot mark was reached. During the period when the new progress figures were being compiled, the project was visited by H.W. Morrison, president of the parent contracting firm with offices in Boise, Idaho. He expressed appreciation of the spirit that moves tunnelers to go all out in their efforts to beat previous records, unmindful of the labor involved.

Following is an analysis of the operations in the first record-breaking week:

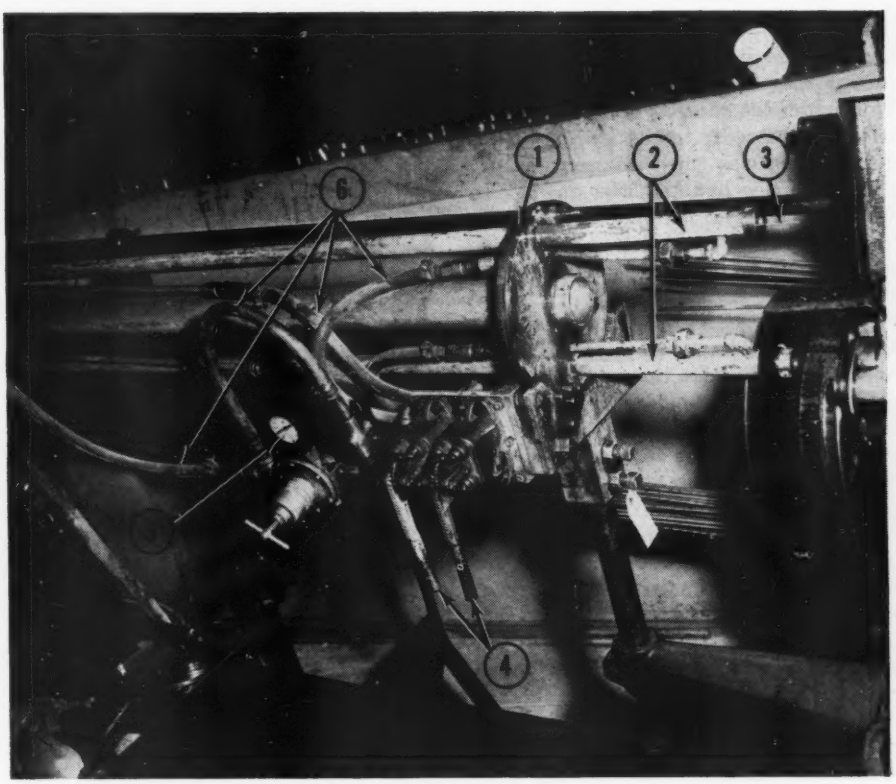
Heading advance for week (6 days) ft	248
Total volume of rock, in place, cu yd	5704
Number DA-35 drills on jumbo	16
Number holes drilled each round	97
Number rounds drilled (12 of 11 ft, 11 of 13 ft)	23
Average daily advance, ft	41.3
Average advance per round, ft	10.8
Average volume of rock removed per round, cu yd	248
Average drilling time per round	93 min
Average footage drilled per round	1147
Total footage drilled	26,385
Average mucking time per round	181 min
Average cubic yards mucked per hr	82.5
Average powder (40%) per cu yd, lb	3.61
Average number of men per shift	44

Air-Feed Boosts Screw-Machine Production

ACCORDING to Lloyd Conlay, foreman of the screw-machine department of Clary Multiplier Corporation, San Gabriel, Calif., a new type of air feed has increased production about 75 percent. The screw machines are used to groove shafts for adding machines and cash registers. Each has a bearing surface and as many as six grooves at each end, which necessitate machining stock in lengths up to 14 inches to tolerances of plus-minus 0.001 inch for diameter and 0.002 inch for length between grooves.

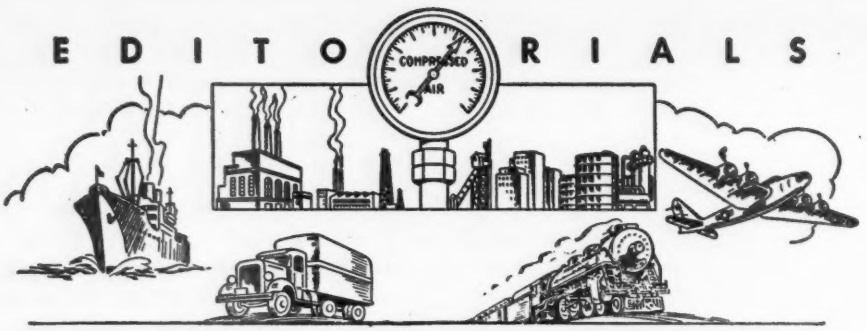
The feed mechanism consists essentially of two long horizontal tubes with pneumatically retractable pistons. Both cylinders are held in a rotating indexing device which, when turned by hand, reverses the positions of the tubes. With the piston retracted, bar stock, up to ½ inch in diameter, is inserted into the tube in the "up" position. When the latter is loaded it is indexed in the "down" position and air at 5 psi is applied to feed the stock automatically into the screw machine. The arrangement is such that one tube can be loaded while the other is working, thus saving the time normally lost in reloading with conventional feeders. Air is supplied by a centrally located compressor and controlled by a 4-way valve.

Use of the new mechanism involved no alterations in the basic screw-machine setup aside from designing a special turret with adjustable adaptor bars which serves as a stop for material of varying lengths. The sequence of operations is as follows: Stock is fed into the machine until it comes in contact with the turret; circular forming tools on both cross slides of the machine separately groove each end of the shaft (the tools alternate with the air feed); a vertical cutoff severs the shaft from the unmachined material; stock remaining in the cylinder is moved up to the stop by the piston; and the cycle is repeated until the tube is empty and replaced by a full one.



FEED AND INDEXING MECHANISM

1, Indexing device; 2, pneumatic feed tubes; 3, bar stock; 4, air controls; 5, air gauge; 6, air lines.



GOLD — ENIGMA METAL

DURING the depression of the 1930's the gold mines of Canada contributed importantly to the Dominion's income. It has even been said that they kept the nation out of bankruptcy. It will be recalled that the United States Government had raised the price of the yellow metal from $20.67 to $35 an ounce in 1933, and as Uncle Sam was the biggest buyer, the new figure became the established world price.

Labor and supplies were cheap, and the industry flourished. The Canadian output jumped from 2,949,309 fine ounces of gold in 1933 to 5,095,176 fine ounces in 1939. Prospectors took to the bush in large nunbers, and many deposits were discovered. New mining camps sprang up, and old ones that had grown anemic regained some of their former vigor. To accommodate the influx of people, homes and stores were built, water and power were made available, streets were paved, sewers laid, and schools and hospitals erected.

But with the coming of war, miners began to leave for military service or jobs in essential industries, and to hold any semblance of a working force wages has to increased. In the United States gold mining was ruled unessential, and the properties had to close down. In Canada, however, the industry was too important to be treated that way. The government wanted the wealth it was contributing and therefore permitted, even encouraged, it to continue. Obstacles kept piling up, however, and its position steadily deteriorated.

The inflationary period that followed the war and is still with us further harassed gold producers. Only the richest mines have been able to show profits of substance, and many of the leaner ones have succumbed to ever-mounting costs. To keep the starving industry alive, the Dominion Government established a modest subsidy program. This helped for a time, but relentlessly rising costs soon threatened further decimations of the ranks. The most recent blow is the elevation of the Canadian dollar to a premium position. In the past two years it has gone up 14 percent in relation to the United States dollar. With gold tied to the latter, the price received for newly mined metal north of the border has declined from $38.50 an ounce to $33.60.

Managements of Canadian gold-mining companies have been complaining of their plight for some time, but their pleas for relief have not been acted upon. Now the residents of mining communities are also raising their voices. In November, representatives of camps scattered throughout the Dominion visited Ottawa to put their case before Prime Minister St. Laurent and his cabinet. They filed briefs and gave personal testimony. Typical of their presentations was the statement that workers employed in gold mines in Ontario Province had declined from 32,551 in 1941 to 12,860 in 1952.

Some of the gold towns have lost so many people that the few who are left can finance municipal affairs only with difficulty. "As you know," the cabinet was told, "our communities must have schools, hospitals, churches and other buildings. But in the last years, with the future of the gold-mining industry so dark, we have often been unable to complete the sale of the debenture bonds to pay for these necessities, even when we have offered as much as 5½ percent in interest."

The delegates suggested certain remedies, but expressed their willingness to leave the choice of action up to the government and the mine owners. Raising the price of gold from $35 to $45 an ounce in United States currency was recommended as the best long-term relief measure. But this could hardly be done without first gaining the consent of the International Monetary Fund, to which major nations are committed to uphold the official price.

In discussing the matter editorially, *The Northern Miner*, Canada's leading mining newspaper, points out that, contrary to popular opinion, the United States is no longer the leading buyer of gold and that not all the gold that is produced is put back in the ground at Fort Knox, Ky. The paper asserts that, according to the International Monetary Fund, six countries each bought more at $35 an ounce last year than did Uncle Sam. The leader, by far, was Canada itself, with purchases of $262 million.

An even bigger customer, though, was the private citizen who, in the aggregate, bought $694 million worth. Excluded, of course, were Uncle Sam's nephews, who cannot legally buy or possess gold unless it is in the form of trinkets, jewelry, etc. Here is evidence that gold is still eagerly sought by the man in the street, despite the fact that it has been stripped of some of its former prestige in government circles. The ironical angle to the whole affair is, of course, that the noble metal, once a symbol of plenty, isn't yielding those who toil to win it from Nature's storehouses enough to buy their salt.

DESERT DETONATIONS

MODERN technology is based largely on laboratory research. Industrial processes are developed and tried out on a test-tube scale before capital is risked to put up full-size equipment. An effort is now being made to use the same small-scale methods in determining some of the effects of nuclear explosions. Under the sponsorship of the Corps of Engineers, U.S. Army, physicists of the Standard Research Institute have been engaged in the task for two years.

Their laboratory is the bleak, uninhabited, sparsely vegetated Nevada desert. There they set off charges at varying depths underground and record the results. About 75 gauges, some stationed on the surface and others below it at different distances from the blast, receive the impulses and transmit them through cables to an instrumentation truck, where they are registered on oscillographic film for later study.

Utilizing small explosions to predict the effects of large ones is called scaling, and if projection of the results is to mean anything, care must be exercised at every stage. To obtain a symmetrical blast it is necessary to initiate it precisely in the center of the charge, which consists of approximately 250 pounds of TNT cast in the form of a sphere about 20 inches in diameter. By sighting through surveying instruments before and after an explosion, the movement of the soil in its vicinity is accurately measured. The dimensions of the crater are also taken. Some larger blasts were set off in the summer of 1951 near Dugway, Utah, to determine the effects of underground detonations on buildings both of conventional and special construction. Charges ranging up to 160 tons of TNT were fired.

Only tentative conclusions have so far been drawn from the experiments, but the field work is to be continued for a year or more and may even lead to further studies. Because the information gained is of military significance, it is being withheld for the present. It has been stated, however, that the researchers are learning that the total effects are highly complicated and that they are profoundly influenced by the characteristics of the soil in which the explosion takes place.

This and That

Spuds Without Jackets

If you peel a potato and expose it to the air its surface soon turns dark. That is, it does unless the potato is of the Pre-Pared kind. This new variety of spud undergoes special treatment by a process controlled by Miller's Prepared Potato Company, of Blue Island, Ill. Following peeling by machine, the potatoes are de-eyed by girls and then, either in sliced or whole form, are coated with a liquid of undisclosed composition and quickly chilled in a York cooler. This treatment apparently renders them safe from deterioration for several days, during which time they are distributed to homes and public eating places. Some restaurants that use them report savings in cost up to 30 percent through the elimination of paring and slicing.

★ ★ ★

Ancient Copper Age

A Swedish expedition is now en route to India to explore the remains of a copper age that flourished at Bikaner, a desert region near Lahore, from 3000 to 2000 B.C. The party of seven scientists is headed by Dr. Hanna Rydh, well-known archealogist, who, with a group of Indian colleagues, visited Bikaner in 1951. At that time many interesting artifacts were uncovered, including red pottery decorated with black drawings. Bikaner was once inhabited by a people who came to northern India before the Indo-Europeans and reached a high cultural plane. Little is known about them, but the area is rich in heaps of ruins that have never been excavated. The expedition will work in close coöperation with Indian archaeologists.

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Uncle Sam's Cave

A Kansas cave is expected to solve a government storage problem. The cavern, near Atchison, formerly a respository for foodstuffs, now houses machine tools that are not yet needed in the defense production program. Following World War II, surplus equipment of this kind was stored indoors in standby Ordnance Department plants. When these units had to be reactivated, the tools were moved outdoors and suffered rapid deterioration.

The Kansas cave provides 650,000 square feet of space and has an average height of 12 feet. Rock cover ranges from 30 to 120 feet and averages 80. There are two entrances, with concrete portals, and the cavern is well lighted and ventilated. Three railroad lines run close by, and a covered ramp leads from a loading dock to the entrances. Annual rental and maintenance costs for the cave will run about 7½ cents per square foot, as compared with 50 cents for space in a commercial warehouse.

POTENT SAFETY MESSAGES FOR VACATIONERS

It has been said that the greatest safety device is a careful employee. Industrial workers nowadays probably encounter most of their hazards while away from their jobs. Management can't do much about the problem thus created except urge them to exercise care at all times. This picture illustrates how that was done at the Western Electric Company plant in Allentown, Pa., last summer just prior to a vacation shutdown of two weeks for the 3600 employees. It was realized that many of the workers would be driving considerably during their absence. To impress them with the need for caution, the two large signs shown were erected in conspicuous places on the fence of the plant parking lot.

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Robot Spare Heart

The "mechanical heart" that made the front pages of many daily papers a few weeks ago depends upon compressed air for its operation. In a Detroit hospital the machine took over the function of one side of a 41-year-old man's heart while surgeons worked on its valves. The operation itself took only fourteen minutes, but the mechanical heart was in action for 50 minutes. The patient, whose heart had been affected by rheumatic fever, recovered and is alive today.

The artificial heart was developed by Detroit doctors and General Motors Corporation engineers. It is, in effect, a motor-driven pump that circulates 4½ gpm of blood, just as a real heart does. The gentle squeezing action of the human heart is induced by air pressure which is brought to bear inside a finger-like tube of rubber within a glass jar into which the blood flows through valves each time it makes a circuit. As the finger is inflated, a pulse of blood is forced out of the bottle and into the body. The discharge valve then closes, suction deflates the finger and the inlet valve opens to admit another surge of blood from the body. This action, if continued on the time schedule of the human heart, duplicates the "beating" action of that vital organ.

★ ★ ★

Drama in a Tank

After spending 55 minutes repairing a submarine pipe line off Staten Island, N.Y., in 103 feet of water, where the pressure is approximately 45 psi, John I. Tooker, Jr., a 32-year-old diver employed by Merritt-Chapman & Scott Corporation, contracted a case of compressed-air illness or "bends." When he failed to respond to treatment in the company's decompression chamber, he was taken as quickly as possible to the Navy Supply Depot at Bayonne, N.J. After the case had been classified as serious, William A. Dorley, a Navy expert and instructor in open-sea diving, volunteered to enter the recompression chamber to attend the stricken man.

The two spent 25 hours in the tank where the air pressure was first pushed up to 80 psi to relieve the patient's painful muscular spasms and then reduced slowly. As the hours passed, Dorley checked his companion's condition fre-

quently and reported continually by telephone to Lt. J.J. Lawson of the Navy Medical Corps, who was standing by outside to give instructions. There was no way of getting food into the chamber without breaking the pressure, so the two principals in the drama fasted. A week after his experience, Tooker was back on the job far beneath the surface of the murky water at the site of new Pier 57 in the Hudson River.

★ ★ ★

Air Brakes Saved His Life

Passengers on trains have all seen a conductor or brakeman signal the engineer by pulling the overhead cord and thus liberating blasts of compressed air from the brake-line system. When George Burns, a brakeman on the New Haven Railroad, fell between two cars of a standing freight and was so badly hurt that he couldn't rise, he knew he would be crushed when the train moved unless he did something about it. No other trainmen were near, but he thought of a way of communicating with them through the air line. Reaching up, he broke the air-hose connection between the two cars. Other members of the crew found him when they traced the cause of loss of pressure in the brake system.

★ ★ ★

Air Puts on the Squeeze

Wooden ships aren't the most modern kind but may be the safest in warfare, especially where there are fields of floating magnetic mines that are attracted to steel hulls. For that reason the Navy has awarded Higgins, Inc., of New Orleans, La., a contract to build ten 165-foot wooden minesweepers at a cost of $15,000,000.

Large timbers aren't available anymore, so the heavy pieces are built up of laminations. The usual method of gluing the laminates and clamping them together mechanically until the adhesive dries isn't satisfactory because the full pressure is exerted under the clamps only, while intervening areas are held together less securely. Even under the clamps the pressure decreases as the wood shrinks, and the clamps have to be tightened periodically.

In order to overcome these drawbacks, Higgins uses a press in which air pressure holds the layers of wood together. When the wood shrinks, the pressure is increased to compensate therefor. Moreover, the air exerts equal pressure everywhere and does a uniform job. The glued laminates are placed in a press, covered with a tarpaulin, and held under 150 psi pressure for ten hours, meanwhile being heated with steam. A section built up in this way is claimed to be three times as strong as a solid piece of wood of the same size.

★ ★ ★

Briny Iron Mine

Salvors have so far recovered 12,000 tons of scrap iron and steel from the former German battleship *Tirpitz*, which was sunk in a Norwegian fjord during World War II. The salvage company, Einar Hovding, estimates that 40,000 more tons remain to be brought up, and sets four years as the time that will be required to complete the job of dismembering and raising the big ship. The working depth ranges from 90 to 116 feet, with the lower part of the vessel buried in mud.

Moles Awards to Kiewit and Palmer

THE Moles, New York organization of men engaged in heavy construction work, will honor Peter Kiewit and Edward P. Palmer on February 4 for "outstanding achievement in construction." Mr. Palmer is a member of The Moles, Mr. Kiewit a nonmember.

Mr. Kiewit is president of Peter Kiewit & Sons' Company and affiliates, with headquarters in Omaha, Neb. In 1920 he started work as a bricklayer with the firm his father founded in 1875 and rose to be its head in ten years. During the 22 years since his accession the company's worth has risen from $500,000 to around $17,000,000.

PETER KIEWIT

The Kiewit firm has been identified, either alone or with other contractors, with the building of such well-known large dams as Bull Shoals in Arkansas, Hungry Horse in Montana, Garrison in North Dakota, Fort Gibson in Oklahoma, Philpott in Virginia and Boysen in Wyoming, as well as with the Northern Greenland airbase, known as Project Bluejay, and the New Jersey Turnpike. The company has carried out contracts in South America, Alaska, Guam and the Hawaiian Islands.

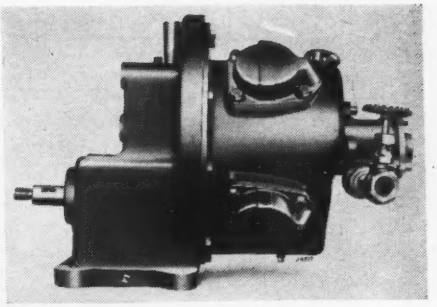
Mr. Palmer heads the New York City firm of Senior & Palmer, Inc., which specializes in pneumatic-caisson work recognized in the profession as one of the most difficult kinds of construction. It had a part in the building of the Seventh Avenue and Eighth Avenue subways in New York and helped to put in the foundations of numerous bridges, including the George Washington spanning the Hudson River. At present it is cocontractor on the New York Central's Harlem River crossing in New York.

Mr. Palmer has been in the construction field for 46 years. He was graduated from Swarthmore College in 1906 and has served on the school's board of managers. He was a captain in the Army Transportation Corps in France in World War I and has been secretary-treasurer of the Transportation Corps (A.E.F.) Association.

He has long been a worker for the betterment of the contracting business. During NRA days he was a member of the Contractors Code Authority. He is a past president of the Associated General Contractors of America, and for thirteen years was a member and for six years chairman of that group's labor-relations committee. He served on the advisory committee on construction matters of the Munitions Board and was industry member of the National Joint Board for the Settlement of Jurisdictional Disputes in the Construction Industry. For six years he was a director of the United States Chamber of Commerce.

EDWARD P. PALMER

Air Mules



IMPROVED AIR LOCOMOTIVE

The low-pressure Air Tram pictured here is making a test run with three mine cars but is built to haul from four to eight, each with a capacity of about 20 cubic feet, on grades from ½ to 2 percent, depending upon the condition of the track, the number and radii of the curves, etc. It is driven through easily removable chains and sprockets by an EE3G air motor such as shown. The bumper is of new design for greater locomotive protection and more leeway in coupling. The operator's seat is provided with a foam-rubber cushion for comfort.

WHERE mine or tunnel track haulage is less than half a mile long, where grades do not exceed 2½ percent, and where air at 100 psi pressure is available, pneumatic locomotives are often applied to advantage. The Mechanics Service Company of Cripple Creek, Colo., builder of the original low-pressure Air Tram, has recently put on the market a greatly improved model which marks a big step forward in this field of transportation.

The first compressed-air locomotive, built in 1873, was inspired by the desire to provide a tractor for coal-mine haulage that would be safer, more reliable and economical, and less complicated than the electric systems that were then replacing hand and mule tramming in large mines. Air motors were comparatively crude and inefficient at that time. To develop enough power to pull a string of cars, the "air hogs," as they were often termed, required exceedingly high pressures that called for large multistage compressors, heavy-duty air lines, and bulky air tanks on cumbersome machines that had a limited field of application. Hence the air-driven locomotive was slow in developing, but experimenters kept the idea very much alive.

In 1904 the colliery of the International Coal & Coke Company, Ltd, of Coleman, Alta., was equipped with a compressor and three air locomotives by Canadian Rand Drill Company, Ltd (now the Canadian Ingersoll-Rand Company, Ltd), and thus became Canada's first air-haulage mine. Air at 1000-1200 psi pressure was needed to run those early tractors, and receivers were usually tested at 1800 psi. Some high-pressure units are still in service, but most installations are of the low-pressure type. Efficient air motors and mechanical improvements in pneumatic trammers now permit the use of a comparatively small tank with a capacity of 49 cubic feet. This is charged with air at 100 psi, and even though the pressure may drop to as little as 5 psi in service it is still sufficient, it is claimed, to drive the newest locomotive.

The Air Tram is operated by a 5½-hp Ingersoll-Rand air motor, and power is transmitted from motor to axle and from axle to axle by 1-inch pitch roller chains engaging hardened-steel sprockets. During recent tests in the Chicago Tunnel of the Globe Hill Mining Company in the Cripple Creek District, a tractor traveled 3300 feet, or 55 feet per cubic foot of air consumed, without refilling its 36x84-inch receiver. During another test, run over the same track on a maximum grade of 2½ percent, the unit pulled three mine cars a distance of 2100 feet on one air charge, or about 40 feet per cubic foot of air used.

The air motor that helps to make this economical short-haul transportation possible is built for heavy-duty continuous service. It is of the variable-speed, radial type that can be instantaneously reversed and cannot be damaged by overload. Its enclosed construction is a desirable feature for underground work because it excludes dust and dirt and permits complete and automatic lubrication of all moving parts. Other advantages are renewable and interchangeable cylinders to and from which air is admitted and exhausted by one rotary valve. To sum it up, this piston-type motor is especially well adapted for service where plenty of lugging power is needed.

Peat as a Roadbuilding Material

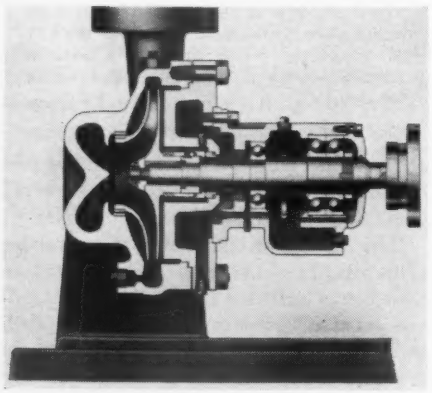
ONE of the greatest difficulties with which roadbuilders in Holland have had to contend is soil of poor bearing capacity because it is generally waterlogged. In the past it has been the practice there to replace such ground with firm sand, a costly and not always satisfactory procedure because the sand exerts heavy pressure on the adjacent instable material and thus often damages flanking structures. On several occasions this has necessitated the construction of deep concrete foundations supported by piling.

Experiments begun before World War II and resumed in recent years have convinced Dutch highway engineers that they have found a low-cost material that will give them the solid base they need and that does not produce the harmful aftereffects of sand fill. Based on tests with highly compressed bales of peat dust and lumps, a stretch of road 28 feet wide and having two sidewalks was laid between a row of houses and a watercourse, an ideal situation because it was known that replacement of the waterlogged soil with sand would only lead to trouble—the remaining soft material would be forced into the water on one side and harmful pressure would be brought to bear against the none-too-firm house foundations on the other.

The section was divided into pits, each 164 feet long. These were unwatered and filled with bales of peat of uniform size laid in neat rows, with loose peat solidly packed in the intervening spaces. On this subbase was placed a layer of sand, 1 foot thick, to serve as a base for the top course. It is reported that the peat foundation, though of comparatively light weight, offers excellent resistance to traffic.

Industrial Notes

To its line of single-stage process pumps Ingersoll-Rand Company has added the SFLA Class which is intended primarily for handling light refinery liquids at temperatures up to 250°F. It is the first refinery process pump to incorporate and to be built around a mechanical shaft seal which, by permitting the use of a completely enclosed stuffing box, eliminates packing maintenance and leakage. The latter is an important factor where toxic or flammable fluids are pumped. No gland is used, thereby obviating gland failure allowing seal blowout. Adequate provision is made for flushing the seal chamber and piping the drainage to a safe disposal area, thus increasing the service life of the seal when



handling dirty or abrasive liquids. Other advantages obtained through the use of the built-in seal are a reduction in the over-all length of the shaft, which means an increase in strength and rigidity of this member, and a decrease in impeller overhang. A Neoprene shaft closure and a flinger ring between the seal chamber and the bearing housing prevent leakage from or into the housing. In other respects the Class SFLA is of the same design as I-R refinery and process pumps, which feature a vertically split casing with centerline support and a balanced impeller that is keyed to the shaft and has renewable, double wearing rings of dissimilar materials on the suction side. The latest units are available in five sizes from 1 to 4 inches and a capacity and pressure range up to 1400 gpm and 600 psi, repectively.

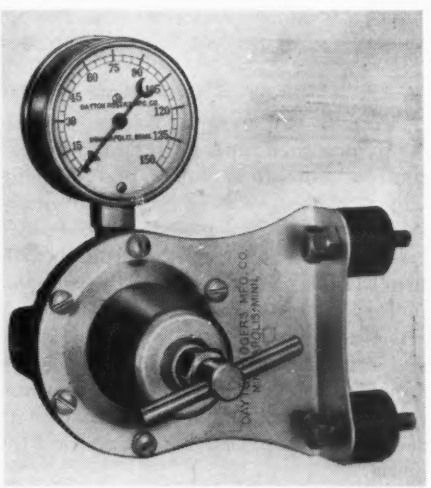
Seeking something compact and sturdy for the safe handling of explosives on construction jobs, Harvey Roach of the Oregon Lane County Electric Co-op found the answer in Army ammunition boxes. He makes the heavy metal containers shock absorbent by lining them with foam rubber 1 inch thick. The caps go in the same box with the explosives, but to segregate them he puts them in a lined baking-powder tin and inserts that in a similarly insulated 2-pound coffee can. Of course, the work of transporting and handling powder should be entrusted only to a trained man, but the method of packaging described has been found to be an excellent safeguard against accidental blasts.

Elgin has brought out an electronic wristwatch that is said to run for a year on an energy capsule ¼ inch long and a motor with a 3000-turn coil. Both parts are ⅛ inch in diameter and take the place of the mainspring and winding mechanism.

A boiler that is entirely automatic in its operation is being developed for small industrial plants by Bituminous Coal Research, Inc., Columbus, Ohio. The unit now undergoing test is designed to convey coal pneumatically from storage and to fire it on a traveling grate. Ashes also are disposed of automatically, and flue gas is cleaned for the removal of solids.

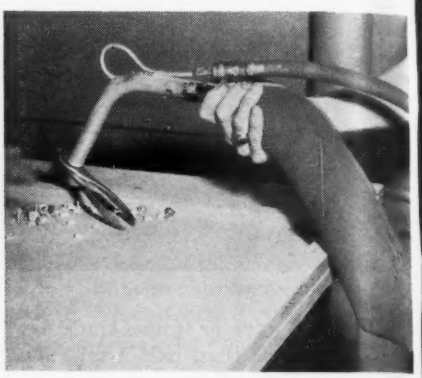
For those who like to keep their tools in good condition ready for use there is now being distributed by Shaeffer Rubber Products Company, P.O. Box 2053, Goodrich Station, Akron 11, Ohio, a saw guard. Made of rubber, it stretches to fit over the edge of a standard saw to protect it during storage or transit. The inner surface is impregnated with castor oil to lubricate the cutting edge and to prevent rusting. It is a product of Sweet Rubber Company.

A combination regulating valve and pressure gauge for compressed air has been announced by the Dayton Rogers Manufacturing Company. The valve automatically reduces primary or shop



air-line pressure to whatever secondary or lower pressure may be required at the point of application and the gauge indicates that pressure. The valve can be utilized without the gauge and is provided with a stop nut to lock the adjusting screw and handle to prevent tampering. It also has two vibration dampeners to safeguard it from shock and concussion caused by the equipment using the air. Sizes to fit ¼-, ⅜-, ½- and ¾-inch pipe connections are available.

Among the standard equipment in service in the overhaul division of the Temco Aircraft Corporation is a small vacuum cleaner, an employee-designed tool for use in wing fuel tanks and other inaccessible places in airplanes. The



main tube is made of stainless steel. It is 1 inch in diameter and has a total length of 12 inches, measuring 9 inches from bag to bend and having a 3-inch radius at the nozzle end. Welded to it and entering it at the bend is a ¼-inch looped pipe connected to an air line. Air introduced by it into the main tube flows back through the straight section and creates a sufficiently powerful vacuum at the nozzle to pick up a pair of pliers, as the accompanying picture shows. It has cut tank-cleaning time nearly in half.

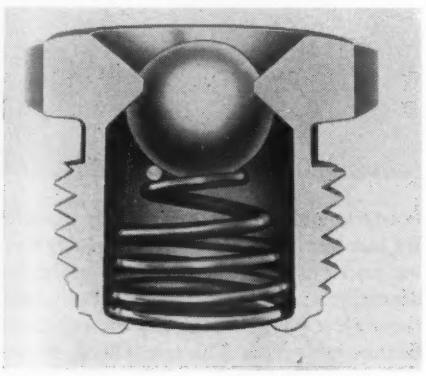
Files that are sufficiently flexible so they can be bent cold into almost any curvature have been put on the market by Thriftool Sales Company, 122 East Twenty-fifth Street, New York 10, N.Y. Made of round stock, they are designed for work on concave surfaces, unusual profiles and corners that conventional files cannot reach. Called Abrafile, the tool is suitable for cutting metals, soft and hard wood, plastics and marble. They have spirally cut teeth that rid themselves of soft material. There are six sizes ranging from 3/32 to ¼ inch.

Two optical flats of unusual size have been added by The DoAll Company to its line of these precision measuring devices. They are 1 inch and 10 inches in diameter, respectively, for checking size, flatness and parallelism of tiny objects such as anvils of micrometers and of large pieces. Made of pure, fused Brazilian quartz, their edges are smoothly ground, beveled and wrapped in a black band on which arrows indicate the measuring surfaces. Each flat is marked with the exact accuracy in millionths of

an inch, which is maintained throughout its full width. Both are obtainable in 1-, 2-, and 5-millionths of an inch accuracy and with one or both surfaces lapped to the specified accuracy.

The installation of electrical outlets on 30-, 18-, and even 6-inch centers for industrial purposes poses no problem, it is reported, with the Plugmold multioutlet raceway system developed by Wiremold Company. It is composed of steel channels, which accommodate 50-foot lengths of Snapicoil with NEMA grounded 2-wire receptacles or with duplex 3-wire receptacles either with both sides "hot" or with one side switched and the other "hot." The prefabricated outlets can be readily mounted at any desired wall level or on the edges of workbenches.

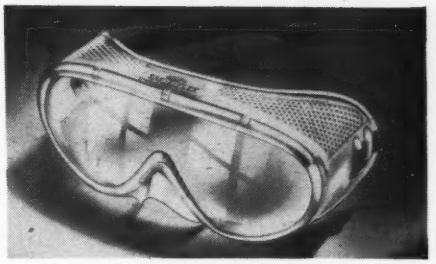
Because protruding heads on ordinary grease fittings are always in danger of being knocked off by a heavy blow or collision, Universal Lubricating Systems, Inc., has designed a flush type that solves the problem. As the illustration shows, it



has a spring-supported ball check which prevents oil or grease leakage in case of back pressure. The ball, which holds the opening normally closed and cannot be unseated, is depressed for oiling, and the spring is designed so that passage through it is greater at the point of fullest depression than at the top of the fitting, thus insuring free lubricant flow.

Bundles of four, eight and twelve aluminum or copper tubes, twisted in a slow spiral-like rope, are run through a flexible conduit for service in connection with pneumatic and hydraulic control circuits. Each tube has an outside diameter of ¼ inch, and the whole bundle is first wrapped in water-repellent insulating tape and then in rust-resistant galvanized steel strip. Connections can be made in standard electrical junction boxes, and individual tubes are coded for quick identification. It is claimed that all pneumatic-control pressure ranges and hydraulic control pressures as high as 3000 psig can be transmitted by the cable. Known as Armortube, it is a product of Bailey Meter Company.

Safety goggles with lenses that can be easily changed have been announced by United States Safety Service Company. The frame is of clear Vinyl plastic that



permits full side vision, has an improved ventilation grid that prevents fogging and has rolled edges for comfort where it comes in contact with the face. The lenses are securely locked in the frame channel at seven points and are optically correct. The goggles are trade-marked

FASTER STOCKPILING at less cost...

10 cu. yd. Sauerman Drag Scraper, pictured above, is handling a 300,000 ton semi-circular stockpile 400 ft. in radius. It stores and reclaims up to 400 tons of material an hour. Entire operation is controlled by one man sitting in a cab overlooking the storage area.

by the

SAUERMAN METHOD

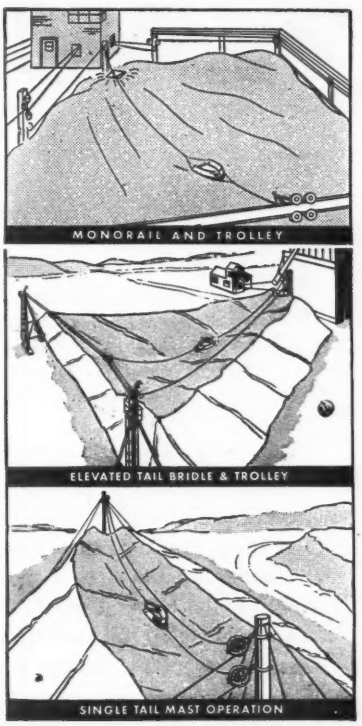
Whether the storage space is small or large—indoors or outdoors—whether the material is light or heavy—there is a type and size of Sauerman Drag Scraper to solve the problem and cut handling costs to the bone.

The Sauerman method is faster and more efficient because its operation is continuous and automatic—all under the finger-tip control of a single operator. The unique Crescent bottomless bucket quickly loads to capacity—carries its load at speed of 400 f.p.m. in straight line to delivery point—empties cleanly and quickly when pull on cables is reversed.

The haul may be any distance up to 1,000 ft. or more for the largest machines and up to 300 ft. for the smallest units.

Initial cost and operating expense both are moderate. The simple maintenance needs are economical. Diesel gasoline or electric power consumption is small compared to tonnages handled.

Write for free illustrated Catalog E, "Bulk Storage By Power Scraper".



Above are three types of Sauerman Scraper Systems used to build economical stockpiles.

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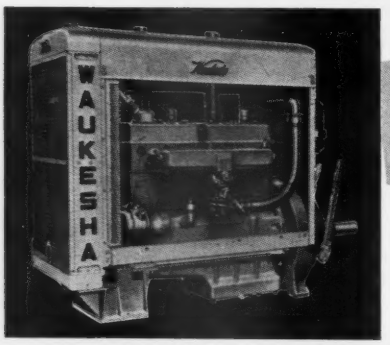
Pioneer packs in power with WAUKESHA

for U.S. ARMY rock plants

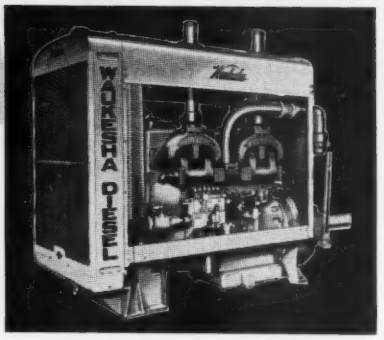


Gasoline

WAUKESHA Super-Duty Six Gasoline Unit (6-WAKU) — 6-cyl., 6¼-in. bore x 6½-in. stroke, 1197 cu. in. displacement powers the plant shown. Get Bulletin 1555.

WAUKESHA

Diesel



WAUKESHA Super-Duty Six DIESEL Unit (6-WAKDU) — 6-cyl., 6¼-in. bore x 6½-in. stroke, 1197 cu. in. displacement. Get Bulletin 1418.

The U. S. ARMY uses portable rock crushing, screening, and washing plants to produce aggregate for air bases, roads, and concrete structures. Shown is a 56-A Primary Crushing Unit, typical of these plants, which Pioneer Engineering Works of Minneapolis, Minnesota, build to U. S. Army Engineers' Specifications with a Waukesha Super-Duty Six Power Unit to drive the crusher, feeders and conveyor. Capacity is 300 to 400 tons per hour with crusher set at 6-inch discharge.

Waukesha Super-Duty Sixes . . . gasoline or Diesel . . . are the choice of power equipment makers, operators and owners alike —for lively acceleration, shock-free operation, and low upkeep with high fuel economy.

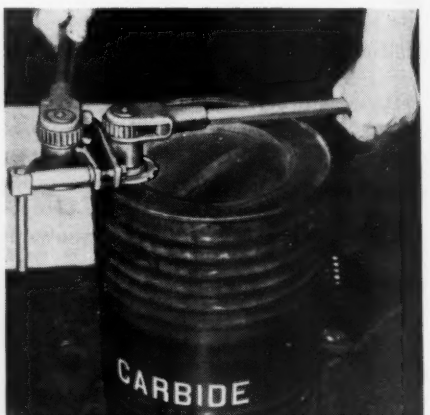
187

WAUKESHA MOTOR COMPANY, WAUKESHA, WIS.
NEW YORK • TULSA • LOS ANGELES

Saf-I-Flex and will fit over the widest personal glasses. Though they weigh but 1.7 ounces they are said to exceed Federal requirements in impact resistance and strength.

Sealed ball bearings that are designed to keep dirt out and lubricant in have been announced by SKF Industries, Inc. The seal is made of stable du Pont Fairprene that is not affected by petroleum-base lubricants, normal operating temperatures and aging. It extends below the steel retaining ring, forming a flexible lip that lightly touches a smooth, uniform chamfer in the inner ring. Known as Red Seal bearings, they are factory lubricated and supplied in standard single-row SAE widths with any combination of snap rings and metal shields. They are interchangeable with conventional nonsealed bearings.

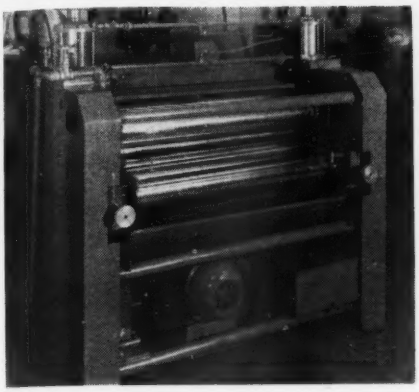
Heads of one-time shipper drums of 24- to 30-gauge steel can be quickly removed, it is said, with a lightweight cutter introduced by Michael A. Schinker Mfg., Company. It was designed especially for cans carrying carbide, caustic soda, cyanide and other substances that might create poisonous or irritating dust



conditions if disturbed during opening by the hammer-and-chisel method. Roller and cutting wheels are 3 inches in diameter, and traction is obtained through two drive shafts mounted in bronze bearings. The tool leaves drums with turned-in flanges that permit using them with safety for other purposes. Secondary porthole covers in heads offer no difficulty.

To speed the work of spreading glue, drawing compounds, plastics, sizing, paint, oil, wax, etc., on flat materials including metal, wood, paper, textiles and rubber, The Union Tool Corporation has developed a series of roller coaters designed to handle sheets from 12 to 108 inches wide and up to 2 inches thick. They are available with automatic infeed and an off-bearing conveyor and with three or four rolls to cover the top or the bottom surface or both sides in one pass.

The thickness of the film is preset by a calibrated hand wheel with micrometer adjustment and, in the case of the unit shown, is controlled by means of two pneumatic cylinders which exert constant pressure on the rolls, thus insuring a coat of uniform thickness. Air at from 20 to 120 psi line pressure is used to actuate the cylinders, but 80 psi is adequate



for most operations. Standard machines are driven at the rate of 75 lineal feet a minute by a constant-speed motor with a gear reduction unit, but variable-speed or geared-head motors are substituted if other speeds are desired. Each coater is equipped with a safety device which immediately stops and reverses the rolls to dislodge anything that might be caught between them.

To give positive visual evidence of the presence of moisture in air or gas lines, King Engineering Corporation has introduced an indicator consisting of a Pyrex or transparent plastic cylinder filled with moisture-sensitive granules of anhydrous calcium sulphate. The unit has brass end plates tapped for ¼-inch pipe and is interposed in the air line leading from the source of supply to the point of application. The granules are blue and remain so as long as the air is dry, but turn pink when it contains moisture or

---

"Am I to understand then that 'boing' is your final answer?"

YE GOOD KING WENCESLAUS

by YE GOOD SAINT "VIC"

Sad King Wenceslaus looked out
At the royal piping,
Faulty lines lay all about
(Those leaks and breaks were griping!)
Then he saw with much delight
What was in his stocking,
He found Couplings sure leak-tight
(Victaulics famed for locking!)

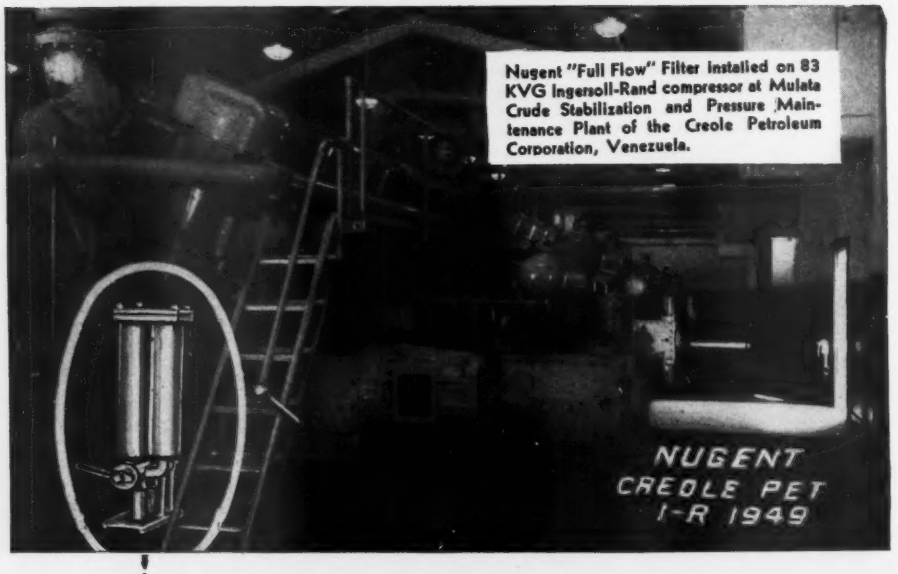
"Ah! Victaulic Fittings, too,"
Roared the King now smiling,
"Elbows, Tees all grooved and true,"
(And Full-Flow in their styling!)
Good Saint "Vic" was in the know,
Vic-Groover tools were waiting,
Kingly smiles began to grow
(Their grooving's tops in rating!)

Zip! The King hooked up those sections,
Saint "Vic" did him rightly
With these very best connections
(No leaks and drips unsightly!)
For a Method that's complete
Wenceslaus is liking
Easiest way to make ends meet
(Victaulic's Four Star Piping!)

VICTAULIC COMPANY OF AMERICA

P. O. Box 509, Elizabeth, N. J. Office & Plant: 1100 Morris Ave., Union, N. J.

"EASIEST WAY TO MAKE ENDS MEET"
VICTAULIC ★ METHOD OF PIPING
★ VICTAULIC COUPLINGS
★ VICTAULIC FULL-FLOW FITTINGS
★ VIC-GROOVER TOOLS
★ ROUST-A-BOUT COUPLINGS



Nugent "Full Flow" Filter installed on 83 KVG Ingersoll-Rand compressor at Mulata Crude Stabilization and Pressure Maintenance Plant of the Creole Petroleum Corporation, Venezuela.

DON'T OVERLOOK THIS CRUCIAL POINT IN COMPRESSOR OPERATION

NUGENT FILTERING MEANS TRIPLE SAVINGS

IT'S the lube oil filtering system, and it can play a big part in your profit and loss statement.

If you put a Nugent "Full Flow" filter in that spot you can be sure of stopping 99.8% of the harmful impurities that get into lubricating oil before they reach the vital working parts of the compressor. This is the kind of filtering that pays for itself many times over in oil savings, increased equipment life and reduced maintenance.

Longer Machine Life

In Nugent "Full Flow Filtering" all the oil being circulated through your equipment is filtered every cycle. No part of the contaminated oil bypasses the filter. Dirt that is removed from the oil collects inside the special Nugent filter bags. When these bags fill up they can easily be cleaned and reused or new replacement bags are inexpensive. In addition, Nugent filter bags have 20 times more filtering capacity than others of comparable size.

Less Maintenance

Whatever type of machinery you use — compressors, gas engines or diesels — Nugent Filters can answer your filtering problems. There is a size and type for every need. Write for complete details.

Less Oil Replacement

NUGENT TRADE MARK

Wm. W. Nugent & Co., Inc.

422 N. Hermitage Ave. CHICAGO 22, ILLINOIS

OIL FILTERS, OILING AND FILTERING SYSTEMS, TELESCOPIC OILERS, OILING DEVICES, SIGHT FEED VALVES, FLOW INDICATORS

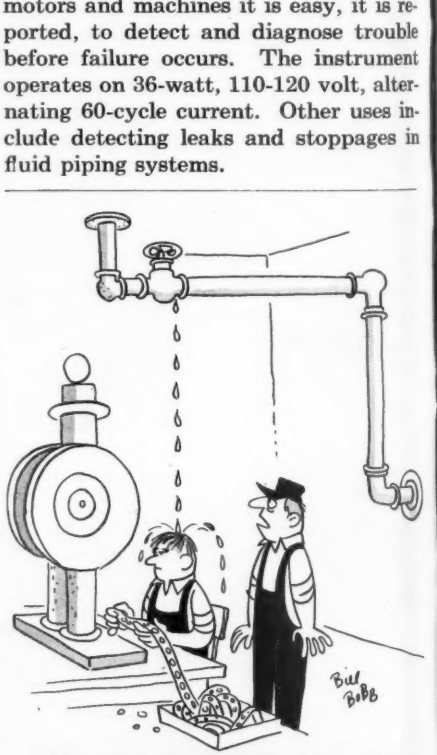
Established 1897

Representatives in Boston • Cincinnati • Detroit • Houston • La Junta, Colo. • Los Angeles Minneapolis • New Orleans • New York • Philadelphia • Portland, Ore. • San Francisco Seattle • St. Louis • Tulsa • Representatives in Canada: Montreal • Toronto • Vancouver

water vapor. Four tie rods protect the separator against damage and permit dismounting for recharging. The granules can be reused by baking them at about 400°F until their original color is restored. When utilized in connection with a drier, the indicator shows when the former needs recharging. With air delivered at the rate of 5 cfm the resultant drop in pressure is said to be less than 1 inch of water.

For the purpose of analyzing and locating sources of noise and vibration in mechanical devices while they are in operation, Erwood, Inc., has developed a pick-up probe and 3-stage amplifier. Named Electro-Probe, it is said to be a

thousand times more perceptive than the human ear but unaffected by air-borne noises because it is sensitive only to vibrations at the point of contact. Speaker or headphones are provided for audible comparisons of sounds within the 60-decible range and a calibrated meter for visual indications. By systematically checking critical points on running motors and machines it is easy, it is reported, to detect and diagnose trouble before failure occurs. The instrument operates on 36-watt, 110-120 volt, alternating 60-cycle current. Other uses include detecting leaks and stoppages in fluid piping systems.



"Doesn't that continuous drip drip get you down?"

QUOTES

—FROM HERE AND THERE

Protective Skin for Ladles

"Aluminum foundry engineers have found a way to double the life of mild steel ladles. They are covering them with a high temperature ceramic coating developed by California Metal Enameling Co., Los Angeles. The coating—which withstands severe heat and thermal shock—protects the ladles against the molten metal to extend their life and reduce down time."

From Steel, October 6, 1952

Toy for Adults

"A visitor (at the 34th Annual National Metal Exposition, held in Philadelphia) needn't be a superscientist to enjoy the exhibits, because here and there around the floor are some pretty fancy gadgets, including a contraption that's a sort of hybrid pinball game and air-valve display set up by the Lindberg Engineering Company.

"There's a little plastic ball that rolls down a winding metal track. On the way it passes a lot of little traps opened or shut by air valves. There's a handle controlling the air valves on the front.

"To win, all a visitor has to do is to close the right trap at the right time, and if the little ball doesn't get sidetracked, it winds up in a pocket marked 'The Jackpot.' There's a tidy set of metal ash trays for winners."

George R. Staab in The Evening Bulletin, Philadelphia.

Coal Gasification

Scientists and technologists of the United States, Great Britain, France, Russia, Italy and Belgium who have been working with the direct gasification of coal have presented their latest conclusions on the subject at two international conferences held recently in the United States. Among the findings, as released by the Bureau of Mines, are:

"Direct gasification, as opposed to processes in which coal is coked before gasification, is one of the most important steps in obtaining such products as gas, gasoline and chemicals from coal.

"Huge resources of low-rank coals and lignites, which cannot now be exploited economically by standard techniques, are available for direct gasification.

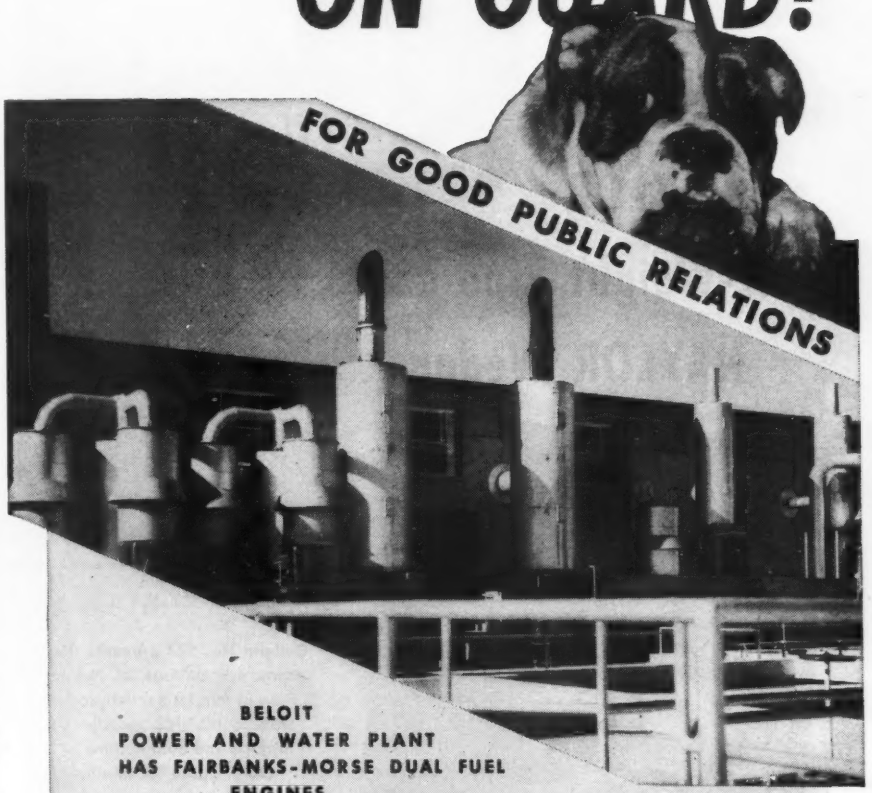
"Both the United States and European countries are developing high efficiency for the gasification of coal won by standard mining methods through large capacity equipment. Feasibility of operating under atmospheric pressure and at 30 atmospheres has been demonstrated.

"Experiments, using air on underground gasification of coal in the bed have been carried out, with the resultant

MAXIM SILENCERS

ON GUARD!

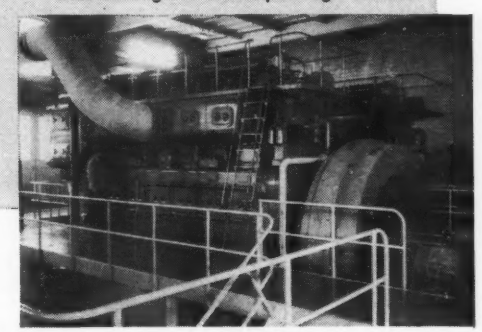
FOR GOOD PUBLIC RELATIONS



BELOIT
POWER AND WATER PLANT
HAS FAIRBANKS-MORSE DUAL FUEL
ENGINES

The new power plant at Beloit, Kansas, is a quiet and good neighbor, 24 hours a day, because of the Maxim Silencers shown above. Illustrated are four exhaust silencers, and behind each of the two-unit oil bath filters a Maxim intake silencer quiets the scavenging air inlet. The larger exhaust silencers serve the two new engines, and the smaller silencers the two older engines. In any municipal plant, good silencing means good public relations. If you have a silencing problem, let Maxim's long experience in this field solve it for you.

The two new 2000 h. p. Fairbanks-Morse dual fuel engines used for power generation.



Consult MAXIM

THE MAXIM SILENCER COMPANY
61 Homestead Ave., Hartford 1, Conn. Dept. W.L.

Gentlemen:
Please send me your bulletins on Exhaust and Intake Silencers.

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Company _____

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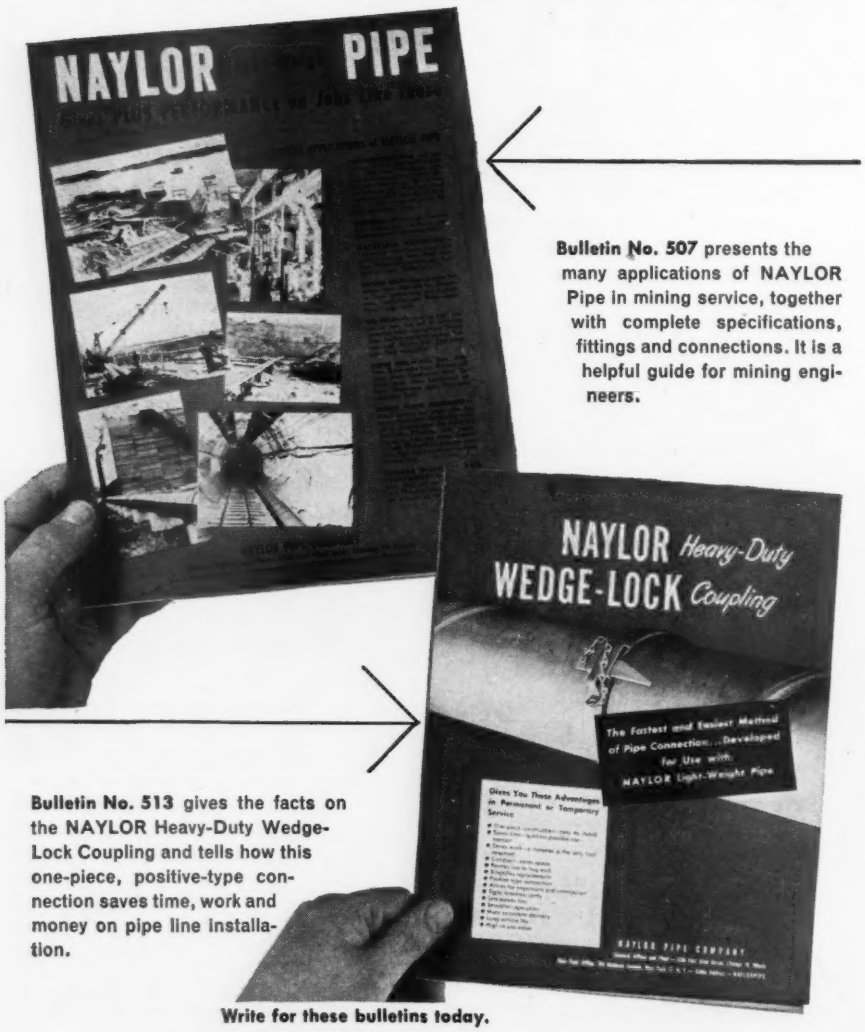
Special Bulletins for Mining Engineers!

Get These Facts on NAYLOR Light-Weight Pipe and NAYLOR Wedge-Lock Couplings


NAYLOR PIPE
NAYLOR Heavy-Duty
WEDGE-LOCK Coupling
The Fastest and Easiest Method of Pipe Connection...Developed for Use with NAYLOR Light-Weight Pipe
Gives You These Advantages in Permanent or Temporary Service
NAYLOR PIPE COMPANY

Bulletin No. 507 presents the many applications of NAYLOR Pipe in mining service, together with complete specifications, fittings and connections. It is a helpful guide for mining engineers.

Bulletin No. 513 gives the facts on the NAYLOR Heavy-Duty Wedge-Lock Coupling and tells how this one-piece, positive-type connection saves time, work and money on pipe line installation.

Write for these bulletins today.

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New York Office:
350 Madison Ave., New York 17, N.Y.

yield of practical and fundamenal scientific knowledge, in Belgium, French Morocco, Italy, the United Kingdom and the United States.

"Additional systematic experimentation in these countries has involved (a) the percolation system using electrical, hydraulic, and pneumatic methods for connecting the vertical boreholes, thus avoiding the construction of underground tunnels; (b) the classical steam method in which preheated air is blown at high velocity through a prepared passage; and (c) a process using parallel passages opened along the pitch of the bed and unidirectional flow of oxygen and steam.

"The common aim of the several systems is to produce gas at low cost, with either air or oxygen, depending upon the type of gas required. The combined results of experimentation show that this is feasible and that the systems are adaptable to a wide range of geological conditions and purposes.

"Successful development of the coal gasification processes in time may reduce underground work, increase productivity, and open to economic access sources of energy previously unexploitable. In turn, both the underground and above ground processes will make the world's large coal reserves a basic commodity for meeting ever-increasing demands for liquid and gaseous fuels, and will open new employment opportunities.

"When eventually developed for commercial application, it is estimated that underground gasification may save Europe several billion dollars a year on its annual coal budget and may benefit the United States by providing new methods for exploiting fuel resources."

Defense Production Record (United States) April 10, 1952

Air-motor Power Jacks

"Air motor power jacks are geared screw jacks and are relatively recent in development, but are finding many applications in the construction field. With these rugged jacks, loads up to 100 tons are lifted absolutely without effort by means of a self-contained air motor. On typical applications, it was found that the ratio of air motor power versus hand jacking was 1 to 9 in favor of air power, with the total elimination of the operator fatigue factor.

"Although these jacks spare the energy of the workman for other uses, caution should be taken to avoid using an oversized jack. A 100-ton capacity jack should not be used to lift a 20-ton load. Jack capacities should be selected to match the load to be lifted in order to obtain the most satisfactory and economical results, as a 100-ton capacity jack naturally is slower than a 20-ton jack."

Frank H. Schwerin in Western Construction, October, 1952

Books and Industrial Literature

Electrical Measurements Manual is the title of a textbook written by C. H. Dunn and H. J. Barker, assistant professors of electrical engineering at Rensselaer Polytechnic Institute, to serve as an elementary laboratory course in electrical measurements. Chapter one gives an extensive exposition of laboratory techniques, while the remainder of the 112 pages is devoted to what the authors consider a well-balanced selection of laboratory experiments. These are divided roughly into two categories: types and characteristics of basic electric instruments and uses of these instruments in measuring electrical and magnetic quantities. Most of the experiments are preceded by a brief discussion, and the questions at the end point to some of the important conclusions a student should draw. As many of them are simultaneous studies of measurements technique and circuit theory, the manual can readily be adapted to circuit-theory laboratories. The manual is published by Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y. Price $4.35.

Reinhold Publishing Corporation is distributing the 1952-53 edition of its *Chemical Engineering Catalog*, the thirty-seventh printing of this standard reference work intended for chemical engineers and production men entrusted with the job of choosing and buying equipment and materials for the process industries. A volume of 2075 pages, it has cross-referenced company-name, functional, classified and trade-name indices and gives comprehensive information on services, supplies and machinery offered by more than 500 leading companies in the field. Requests for copies should be sent to the publisher, 330 West Forty-second Street, New York 36, N. Y.

The Bin-Dicator Company, 13946 Kercheval Avenue, Detroit 15, Mich., is distributing two pieces of literature giving full information on its automatic bin-level indicator and on its low-pressure-air Bin-Flo aerator for bulk materials. Both explain how the units work and what they do and contain diagrams showing methods of mounting on different types of bins.

New Techniques in Control Valve Design is the title of a profusely illustrated 16-page technical bulletin released by the Conoflow Corporation, 2100 Arch Street, Philadelphia 3, Pa. Written by R.B. Werey, president of the company and an authority on the subject, the paper gives a comprehensive review of present-day pneumatic final-control elements and enters into possible future designs. Address your inquiry for a copy to M.B. Benson.

Among several feature articles in E-M Synchronizer No. 36, quarterly publication of the Electric Machinery Manufacturing Company, Minneapolis 13, Minn., is one by its Chief Application Engineer G.L. Oscarson on *Application of Alternating Current Motors to Centrifugal Refrigerating Compressors*. In it he discusses refrigerant characteristics, compressor-capacity control and motor characteristics and control. A copy of the 24-page illustrated booklet can be obtained free upon request.

A bulletin has been published by Taller & Cooper, Inc., describing its new type of sequential data recorder and annunciator for industrial plants and power systems. It is said to keep watch automatically on as many as 500 supervised devices such as circuit breakers, thermocouples, fans, turbines, relays, etc.; to annunciate all irregularities; and to print a sequential log showing the device operation and time of changes in operating conditions even when they occur within milliseconds of one another. Copies are available by writing to the company at 75 Front Street, Brooklyn 1, N.Y.

Ingersoll-Rand Company has released a 15-page bulletin illustrating and describing its general-purpose centrifugal pumps of the standard and heavy-duty cradle-mounted type ranging in capacity from 5 to 2400 gpm. Five basic groups, including seventeen models, are listed, together with their horsepower ratings, dimensions, uses and performances under 60-cycle operation. Two pages are devoted to special-service units and design modifications. Copies of Form 7223 may be obtained from the main office, 11 Broadway, New York 4, N. Y., or any of the company's branches.

J. N. Fauver Company, Inc., 49 West Hancock Avenue, Detroit 1, Mich., has recently released a 24-page booklet describing its industrial-hose assemblies, couplings, stems, swivels and accessories designed for intermediate and very high pressures, for ordinary and elevated temperatures, and for handling all kinds of fluids including solvents, lubricants and plastics. Ask for Catalogue No. 52.

Proved in the laboratory and in the field, Donaldson Air Cleaners meet all the rigid requirements of air compressor applications. Practically all dust, including elusive "extra fines" is removed to reduce wear on compressor parts; and the oil-trapping upper condensing element reduces oil loss from cyclical "blow back" to a minimum.

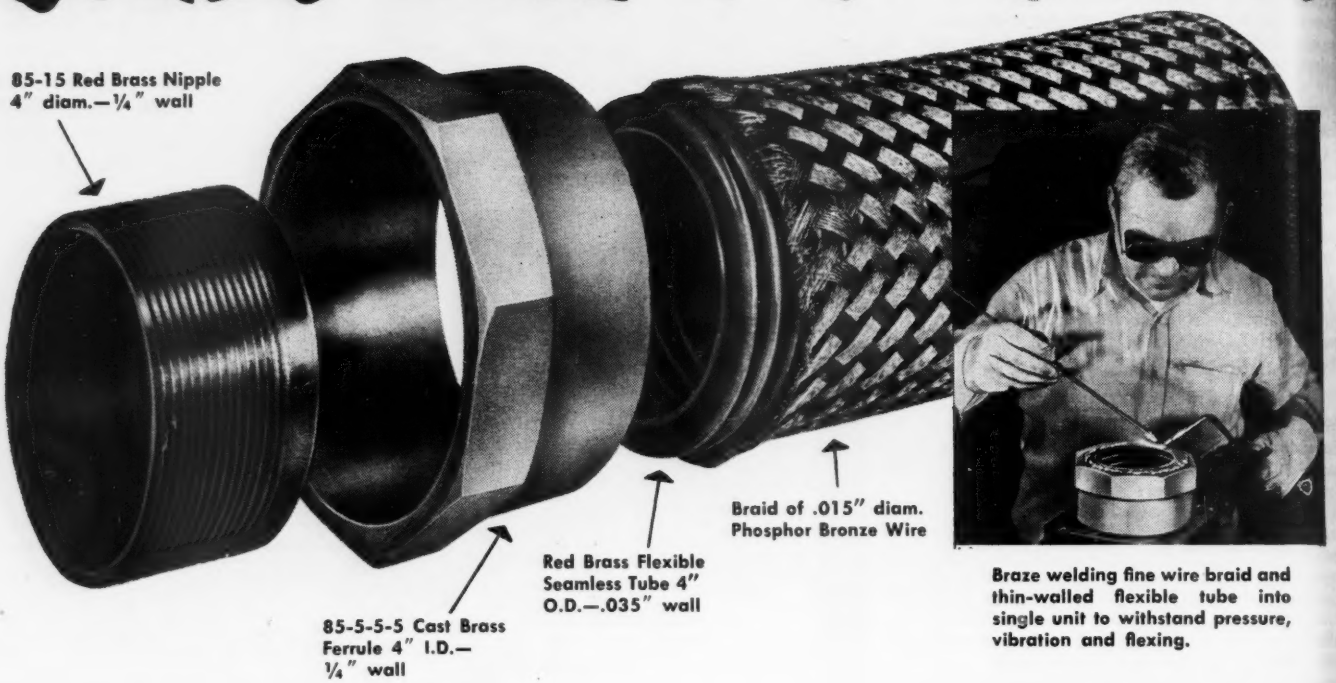
Donaldson air compressor Air Cleaners are used extensively by leading manufacturers on units with a wide range of capacities. Write for specifications.

DONALDSON CO., INC.
666 Pelham Blvd., St. Paul 4, Minn.
DONALDSON CO. (Canada) LTD., Chatham, Ontario
GRINNELL DIVISION: Grinnell, Iowa

Donaldson AIR CLEANERS

How to produce it profitably?

braze weld it-of course!



Braze welding fine wire braid and thin-walled flexible tube into single unit to withstand pressure, vibration and flexing.

This assembly must hold liquids, steam or gas under high pressures—while withstanding vibration and continuous flexing. Made up of dissimilar metals of widely varying thickness, it's braze welded on a production basis with ANACONDA 997 Low Fuming Bronze Rod.

ANACONDA Bronze Welding Rods can keep your welding costs down with fast, strong, uniform welds on even the most difficult production jobs. Our Technical Department will gladly help you with any bronze welding problem. ANACONDA Welding Rods are sold by distributors throughout the United States. The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

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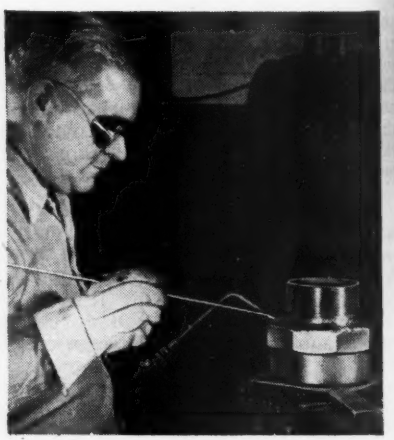
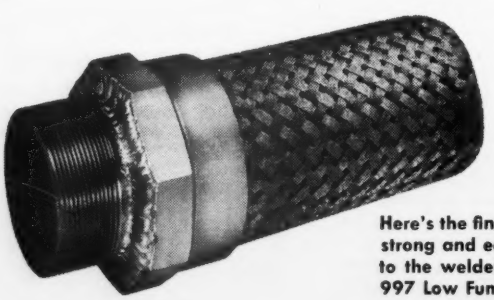


Now the red brass nipple and cast brass ferrule are joined together and to the first weld. This calls for pressure-tight joint between nipple and flexible tube and a strong joint to the ferrule.

For every braze weld, there's an

ANACONDA®

BRONZE WELDING ROD



Here's the finished job, neat, tight, strong and economical — a credit to the welder and to ANACONDA 997 Low Fuming Bronze Rod.

HIGHWAY DEPARTMENT'S MOST USEFUL LOADER

Your Eimco can dig ditches, clean up slides, dig up shoulders, speed up new construction, in tunnels, loading trucks or in quarries loading rock.

The Eimco will load rock at the rate of 4 to 6 tons per minute average and sand or gravel at 6 to 8 yards per minute average.

The speed, efficiency and low cost of Eimcos make them preferred equipment in any highway department. Let us tell you of the many other advantages in using Eimcos.

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THE EIMCO CORPORATION

The World's Largest Manufacturers of Underground Rock Loading Machines

EXECUTIVE OFFICES AND FACTORIES — SALT LAKE CITY 10, UTAH, U. S. A.

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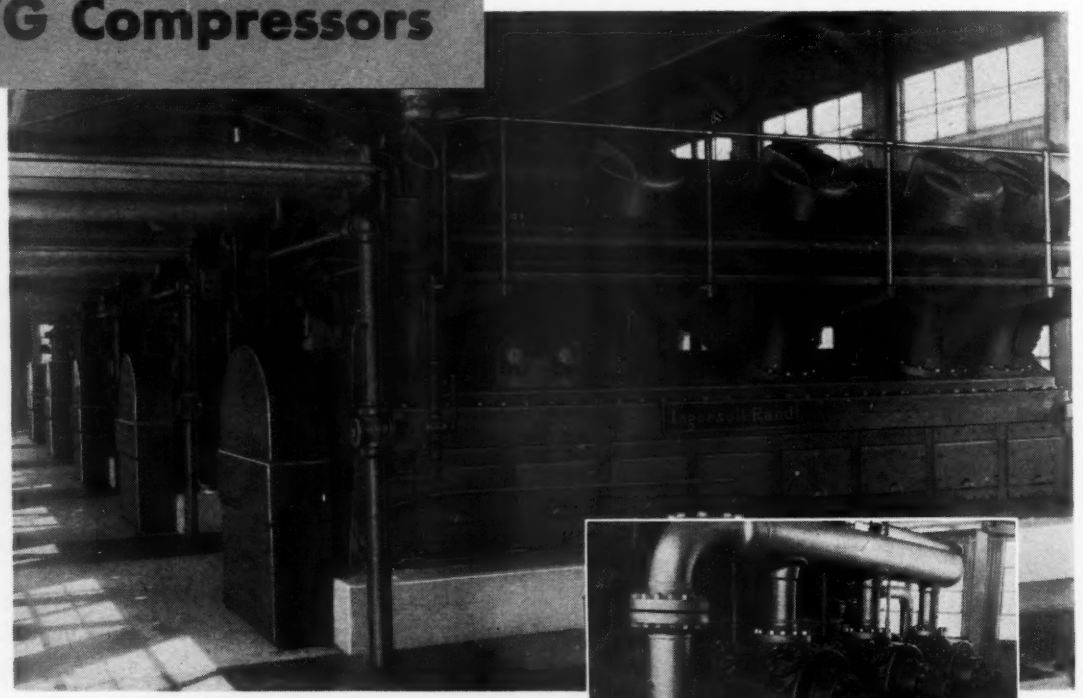
You Can't Beat an Eimco

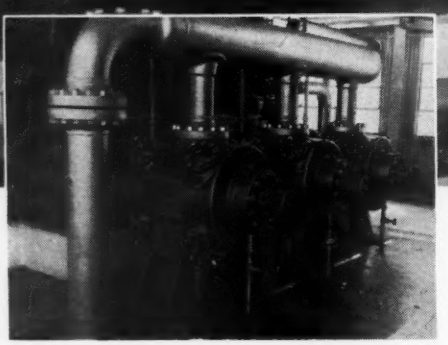
Above: Digging ditch beside highway in Canada. Below, left to right: Clearing rock off highways, taking out shoulder for highway widening, loading in a tunnel, loading trucks in rock quarry.

63 I-R GAS-ENGINE-

SERVE MISSISSIPPI RIVER FUEL LOUISIANA-TO-ST. LOUIS

41 KVG Compressors

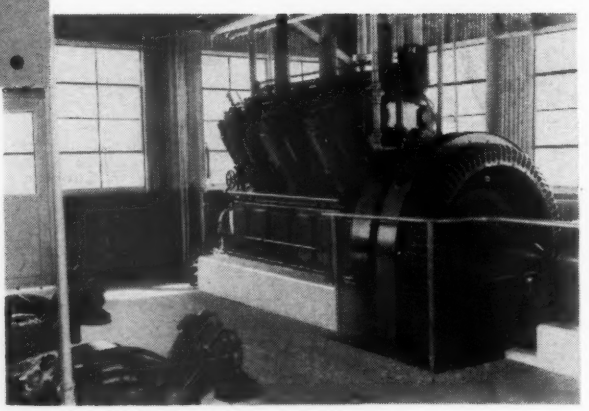




Five 1100-hp Ingersoll-Rand KVG compressors in the Glendale compressor station No. 2 (near Star City, Ark.) in Mississippi River Fuel's 700-psi pipeline. The compressing cylinders of one unit are shown at right.

and 22 Gas Engine Generating Units...

help deliver daily capacity of 400,000,000 cubic feet of gas



An I-R gas-engine generating unit and two air-starting compressors also serve the same station.

COMPRESSORS • AIR TOOLS • ROCK DRILLS • TURBO BLOWERS • CONDENSERS